The portrait here represented was painted during the summer of 1924 by Mr. Arvid Nyholm of Chicago and unveiled at a banquet in honor of Professor Farrington held at the National Dairy Exposition, Milwaukee, October 2, 1924. It will be permanently hung in the Rotunda of Agricultural Hall at the University at Madison.

THE upbuilding of Wisconsin's dairy greatness has been the work of many men—none has made a more devoted and unselfish contribution than Edward Holyoke Farrington.

As professor of Dairy Husbandry in charge of the Dairy School at the University of Wisconsin, he has been teacher, counsellor and and friend alike to those who have come to the halls of learning at Madison, seeking knowledge, and to that larger university of practical dairymen throughout the state.

In recognition of the great services of Professor Farrington to Dairying and to the State during the past thirty years, his friends and former students regard it a high privilege to present his portrait to the University.

A Guide to Quality in Dairy Products

A reference book for the butter maker, the cheese maker, the ice cream maker and the dairy farmer

by

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FIRST EDITION

MENDOTA BOOK COMPANY
MADISON, WISCONSIN
1927

PREFACE

In answering the many questions received each year from former students and others interested in the manufacture of Dairy Products, I have noticed that there has been considerable repetition of the same inquiries. This seems to indicate a rather frequent occurrence of the same difficulties among butter makers, cheese makers, ice cream makers, and dairy farmers in their every day work.

This situation suggested the need of a reference book in which the quality of butter, cheese, ice cream, and milk might be discussed from the standpoint of the producer and the manufacturer.

In order to make such a reference book helpful and handy for daily consultation the inquiries selected for discussion have been collected into four groups, including in each group those referring to one dairy product and arranging them alphabetically so that the one wanted may be quickly found.

The butter making group covers the causes and prevention of common defects in butter: instructions for cream grading, pasteurizing and neutralizing: starter making, butter working, testing and figuring overrun as well as many other problems that come up in the every day work of butter making.

The cheese making group includes a discussion of the causes and prevention of some of the defects in cheese: the paying of patrons for milk by several methods and many helpful hints to patrons about the quality of their cows and their milk.

The ice cream making group of inquiries refers to "overrun," sandiness, weak body, unevenness in flavor, texture, etc., together with many suggestions about causes of good and of bad qualities in ice cream.

The dairy farmer and the cow milker group of questions discusses the causes of variations in milk and cream tests; the effect of individuality and ways of milking as well as many other practices on the milk production of a cow; points on running a farm cream separator; ways of taking accurate samples of milk for testing; why dairying is profitable; the creamery vs. the cheese factory from the dairy farmers standpoint and many other practical questions that come up in the every day work of a cow owner and a cow milker.

A brief discussion is also given of the composition of milk and the distribution of the component parts of milk in the manufacture of Dairy Products.

Acknowledgment is due for helpful suggestions from my former students; to J. W. Moore on a part of the cheese making discussion, and Carl Villebrandt on the ice cream section of the book.

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Quality in Dairy Products

INTRODUCTION

The quality of nearly every crop raised on the farm is to some extent influenced by the climatic conditions of each season. The number of small potatoes in a hill, the hardness and fullness of the grain kernels, the maturity of the corn crop, and the quality of the silage produced on the farm are influenced by weather conditions over which the farmer has no control.

When it comes to the quality of dairy products, however, the weather is not a ruling factor, because the sweetness, and to a large extent, the flavor of milk, cream, butter, cheese, ice cream and condensed milk are not entirely dependent on climatic or seasonal conditions, but are under the control of the farmer and the dairy manufacturer. The farmer especially, if he chooses to do so, can easily protect his milk and cream from climatic or weather influences throughout the entire year.

It is a simple matter for everyone who milks cows to keep the cow stable clean, to milk the cows with clean, dry hands into a clean milking pail, and to separate this milk with a clean separator and cool the cream immediately after separating it. It is also an easy matter for the farmer to provide himself with some sort of a milk or cream cooling tank, not necessarily expensive, but some receptacle cooled with cold water and kept cold until the cans of milk or cream are delivered to a buyer. Everyone who understands farm conditions will undoubtedly agree that quality in the milk and cream sold from a farm has at least this one advantage over quality in other products and crops sold from the farm.

The responsibility of the milk producer is the first point to be considered in our efforts to improve the quality of all dairy products.

Why Second Grade Milk and Cream? If now we start with the above statement as an accepted fact, the next question is, Why is so much second grade milk and cream

produced on the farm? The answer is, that buyers have not universally adopted the practice of grading and of paying more for first than for second grade milk and cream.

A reward for good work is something which a human being has a right to expect, and one can hardly think that careful farmers will continue to cool their milk and cream, scald their separators and other tinware whenever these are used, or deliver their milk and cream when it is not more than two days old to the buyer if they are not paid more for it than is paid for that sold by the careless and the indifferent farmer. This side of the situation has been discussed for many years and is continually presented by persons interested in the buying or selling of dairy products.

High Grade City Milk. One of the best illustrations of what milk and cream producers will do when paid an advance in price for a high grade product, is the history of the milk supply of our large cities.

One of my former students, working at the country receiving plant of a large city milk dealer, informs me that he has seen many thousands of pounds of milk returned to the farmers because it was not up to the standard required by the city milk inspectors.

These standards are constantly going higher in the efforts made to protect the public and to furnish the consumer with what science and practice have both agreed to be reasonable and necessary for the protection of the public health.

The farmer producing milk for a city supply now receives the highest price paid for milk and this price has made it possible for the milk buyer to obtain a constantly increasing quantity that comes up to the high standards and regulations of our State and City Boards of Health.

A Result from Cream Grading. Since a great advance has been made towards the improvement of our city milk supply, by paying high prices for the best milk and refusing to buy, at any price, milk that does not come up to a reasonable standard of composition and cleanliness, this ought to be an incentive that will have the desired effect on the producers of milk sold to cheese factories and condenseries as well as on the producers of cream sold to the manufacturers of butter and the makers of ice cream.

I am informed that at one creamery where the practice was adopted of paying a higher price for a grade of cream

called "special," the percentage of this cream received at the factory advanced from 25 per cent to 58 per cent in one year. I am sure it would have taken many years of preaching to accomplish this result, if no difference in price had been paid for the two grades of cream.

It seems a little contrary to the principle of the "Golden Rule" to think that milk and cream producers must be paid for careful attention to the every-day details of cold and cleanliness as applied to milk and cream production, but many illustrations have demonstrated that this extra pay for doing what everyone knows ought to be done is more of an inducement to continue the good work than the simple statement of "Well done, good and faithful servant," which puts the practice on the high plane of doing a thing right because it is right, but, as one farmer said, "it does not buy many milk cans."

Relation of Butter Grades to Quality of Cream

At the present time butter is bought and sold on the basis of its grade or quality, and so long as butter is made from cream, why shouldn't cream be bought and sold on a similar grade basis?

Among the market quotation of farm produce it will be noticed that butter of the highest quality is given the name of "extras." It may be quoted at 40c per pound on the basis of the quality expressed by the figures "92 score." The next grade of butter may be what is called, "firsts" having a score below butter of the "extra" quality and the market quotation of such butter, "firsts," will be lower than that of "extras" by at least one cent per pound.

The relation between grades of butter or of cheese and the market quotations or selling prices has been so long established that there is hardly a person now living who will remember when it started. This is not, however, the case with milk and cream.

If an analysis of butter market quotations showed that on a certain day 10 per cent of the butter graded as "extras" and sold for 40c, 75 per cent of the butter graded as "firsts" and sold for 38c, 10 per cent graded as "seconds" and sold at 36c, and 5 per cent graded as "thirds" and sold for 33c, it is an easy matter to show the value of cream grading and the

way it may increase the price paid the farmer for his cream that is made into first, second or third grade butter.

Suppose a creamery made 1,000 pounds of butter per day for 30 days and when the 30,000 pounds of butter are shipped to market, 10 per cent of it sold as "extras" or the top market price, 75 per cent as "firsts," 10 per cent as "seconds," and 5 per cent as "thirds." The receipts for this shipment will be as follows:

30,000 lbs. Butter sold as:			
"Extras"---	10 per cent =	3,000 lbs. at 40c =	$1,200.00
"Firsts"----	75 per cent =	22,500 lbs. at 38c =	8,550.00
"Seconds"--	10 per cent =	3,000 lbs. at 36c =	1,080.00
"Thirds"---	5 per cent =	1,500 lbs. at 30c =	450.00
	100 per cent	30,000	$11,280.00

Now suppose a system of cream grading was introduced at this factory and six months later it was still producing one thousand pounds of butter per day and further the 30,000 pounds sold during the month was found to be of such a quality that 90 per cent of it sold as "extras" at 40c a pound; 5 per cent as "firsts"; 3 per cent as seconds and 2 per cent as "thirds." The returns to the factory for this shipment will be as follows:

30,000 lbs. Butter Sold as:			
"Extras"---	90 per cent =	27,000 lbs. at 40c =	$10,800.00
"Firsts"----	5 per cent =	1,500 lbs. at 38c =	570.00
"Seconds"--	3 per cent =	900 lbs. at 36c =	324.00
"Thirds"---	2 per cent =	600 lbs. at 30c =	180.00
	100 per cent	30,000 lbs.	$11,874.00
Receipts as per first shipment			11,280.00
Difference			$ 594.00

The difference between the receipts of the factory for the butter made from graded cream as compared with the receipts from the ungraded cream butter amounts to several hundred dollars, or an average of about 2c per pound advance in price for the butter after cream grading was started and carefully enforced.

Cream grading not only gives the creamery an opportunity to pay more money to its farmer patrons, but the consumer is supplied with butter of a better quality and the butter will keep longer. Further, people will eat more of such butter than of butter having an inferior quality.

A similar comparison of the relation between grades of cheese and the prices that can be paid for milk at a cheese factory will show that the milk producer is largely responsible for the price he receives for his milk made into cheese.

Benefits from Milk and Cream Grading. The consistent grading of milk and cream is a benefit financially to the producer, the dealer, the manufacturer, and the consumer: Such grading ought to stimulate the milk producer to a greater production because he will receive a higher price for the butterfat in both the milk and the cream, and one would naturally expect that the farmer should be the one to insist on the creameries and cheese factories adopting this practice of grading rather than the buyer of these products.

An investigation some years ago, made on the New York and Chicago butter markets, for a period of eight months showed that 44 per cent of the butter sold, graded as seconds and below. One reason for this undoubtedly was the poor cream received at the factories. It caused a loss of thousands of dollars to the producers, which, if saved, would have much more than paid the expenses of grading at the factories where the butter was made.

So long as a farmer delivering second grade milk and cream to a factory is paid strictly on the basis of pounds of butterfat or the test of these, without any reference whatever to their sourness, richness and flavors, just so long will the factories be selling products of different grades and the proportion of first grade or highest priced butter and cheese will continue to be about 10 per cent of the total sold. This state of affairs is not a fair deal for the farmer who produces the clean milk and cream as he must invest more money in equipment at his farm. He must also give more care to the cleaning of his dairy utensils, and this takes more time, which is as valuable to the farmer as it is to anyone else.

Under these circumstances the farmer producing the first grade milk and cream certainly should be paid a higher price

for it than is paid for second grade, because the factory gets a higher price for the product and this price should be shared with the producer of the milk and cream.

Attitude of the Milk and Cream Buyer. The results obtained from milk and cream grading will depend a great deal on the attitude of the buyer toward this commendable piece of work. He must continually encourage his patrons, first by paying them a higher price per pound of butterfat for the sweet than for the sour and second by suggesting what the farmer must do on the farm to produce the sweet milk and cream; he must in every way possible try to work with the farmer and encourage him in his efforts to help himself.

Do not fail to impress upon the farmers the rapidity with which milk and cream sours at different temperatures, and while some farmers will probably not be very much influenced by too many talks about bacteria, it will do no harm to tell them that if milk or cream is kept at a temperature of about 70° F; one bacteria may multiply into 6,000 in 24 hours. If kept at a temperature of 50° one bacteria may only multiply into about 4 or 5 during the same time.

Relation of Cooling Temperatures to Milk and Cream Delivery. On this point a buyer can inform his patrons that if they cannot cool their milk or cream below 60° F. it should be delivered every day. If held on the farm in a clean can at a temperature of 50, the cream at least will reach the factory in good condition if it is delivered every other day.

Loss of Milk and Cream Patrons. Some factory owners, expecially creamery men, have objected to the practice of cream grading because they say it will drive their patronage away. This can easily be answered by the statement that even farmers producing a poor grade of milk or cream have a certain amount of pride, and if the milk or cream they deliver to the factory is continually in the second grade class, this is an acknowledgment that it is not up to the standards of their neighbors' and they ought to be able to do as well as anyone.

A dairy manufacturing plant will soon find when it offers two prices for two grades of milk or cream that the supply

of first grade will increase; there will always be some second grade producers, but such patrons will gradually drop off or go to some other buyers. So long as a premium is paid for good quality in either milk or cream there will always be a tendency to get for that buyer the best milk and cream in the territory and the situation becomes an incentive to those producing a poor grade of milk or cream to try and get into the first grade class. Other buyers will get the second grade stuff, but this one will get the first grade, because a better product can be made from the first grade milk or cream and it sells at higher prices than other dairy products.

Mixing First and Second Grade Milk or Cream. The statement is often made that by mixing poor cream with good cream the defects in the poor cream will be covered up by the good cream. It is true that a small amount of sour cream can be mixed with a large amount of sweet cream without any great effect on the sourness of the mixture, but when this is churned into butter and the butter placed in storage or held for a few weeks after it is made, the effect of the small quantity of second grade cream mixed with the good cream will be noticed in the rapid deterioration of the quality of the butter. The same thing happens with any dairy product made from milk or cream.

Poor Keeping Butter from Second Grade Cream. The butter made from second grade cream when first churned sometimes has a fairly pleasing flavor, and might pass for a few days as butter of good quality. Such butter, however, does not retain its good quality, and within a week it may be so strong that it must be sold for several cents under the ruling market price. Such butter also does not stand transportation, but may spoil enroute to market. Low grades of butter are never good keeping butter.

The same thing is true at the cheese factory; the grade and the keeping quality of the cheese depends on the milk from which the cheese is made.

Standards for Milk and Cream Grading

The easiest way to operate a creamery or a cheese factory is to buy everything that comes to the factory in the way of milk or cream; then sample and test it for butterfat, and

pay all the patrons the same price, which will depend on the money received for the butter and cheese, regardless of their quality.

If, however, the factory owner or the operator is ambitious to raise the standard of the factory product and to increase its patronage, this may be done by paying the high grade milk and cream producers higher prices, by encouraging them to keep more good cows that give them better returns for their labor. Paying two prices for milk and cream, one for first, and another for second grade, may easily be done by cooperating with the patrons in trying to improve the arrangements at the farms where the milk and cream is produced and held until delivered to the factory.

When it has definitely been decided to introduce the practice of milk and cream grading at a factory, the question of standards for each grade to be used, and the number of grades, must be determined.

The important points to be considered are, 1, *flavor*, 2, *acidity*, and 3, *richness*.

1. *The flavor* of either milk or cream must be determined by the grader's knowledge of the good qualities desired. He will soon be able to distinguish objectionable odors that may be carried from the milk or cream into the butter or cheese and on the basis of this knowledge he can form his opinion as to whether each particular can of milk or cream is first or second grade in so far as flavor is concerned.

The *age* of the milk or cream when it is delivered to the buyer has less influence on the sourness and flavor than the *cleanliness of the milk utensils, the farm separator, etc.*, provided the new milk or freshly skimmed sweet cream at the farm is immediately placed in scalded cans and cooled to a temperature of 50° F.

Cream that has been kept for several days on the farm at a cold temperature in clean cans will make butter of a better quality than cream one day old which has been skimmed by a sour separator and poured into a cream shipping can without very much cooling and then delivered to the cream buyer daily. The same is true of milk sent to a cheese factory. The age of the milk is not of as much importance as the cleanliness and the cold provided by the producer on the farm.

Sweet, rich milk and cream of good flavor will make butter and cheese of the best quality, but sour, thin milk and cream with objectionable flavors will make butter and cheese of poor quality.

2. The standard of *acidity*, of sweet milk or cream is 0.2 per cent or less. This is a good one to adopt for the purpose of drawing the line between sweet and sour milk or cream. The method of testing a great many lots of cream, by means of the alkaline tablets designed for this purpose, has been worked out in all its details and can easily be practiced by anyone accustomed to the work of a dairy manufacturing plant, see p. 15.

3. *The richness* of the milk or cream is not of so great importance in determining whether or not it should be classed as first or second grade, as the flavor and the sourness, but first grade cream should certainly test at least 25 per cent fat, and even richer is commendable.

First grade cream, therefore, should include all cream having a sweet, agreeable, creamy flavor, and no objectionable odors, with not over .2 per cent acidity and not less than 25 per cent fat.

Whether or not cream which does not come up to this standard, that is, cream which tests less than 25 per cent fat, more than .2 per cent acid, and may contain some objectionable odors and flavors, should be classed as second grade, or whether there shall be a third grade, depending on the extent to which the acidity has developed and the bad flavors predominate, is a question which has been discussed and decided by the buyers in different localities according to what seems to them to be the most appropriate for that locality.

There is not much to be gained by multiplying the number of grades. Two grades are sufficient for all practical purposes, as the work of grading must be done rapidly and conscientiously with a genuine effort and intention of helping the farmer get a high price for the time and labor he is devoting to his milk and cream production.

The plan of dividing the milk or the cream at a factory into two grades and no more, simplifies not only the grading; but the business of paying two prices rather than three or

more, which may complicate the question without being of any great advantage to either the buyer or the farmer.

Cream Grading in Different States. During the past few years the subject of cream grading has been discussed by dairy authorities in at least ten different states. They nearly all have agreed on dividing cream into two grades, sweet and sour, and paying about 4c a pound butterfat more for first than for second grade cream. There are, of course, minor deviations from these two grades and variations in the interpretation which each authority makes of first and second grade cream, but the majority opinion seems to be that first grade cream shall be rich, sweet and clean, testing at least 25 per cent fat, not more than .2 per cent acid, and have a rich, sweet cream flavor. The butter fat in this cream is certainly worth 4c per pound more for making butter than the fat in sour cream, which may contain objectionable flavors, and I am convinced from the experience we have had in buying milk and cream from over 200 farms at our Dairy School that when the standard of first and second grade cream is adopted as the basis for buying cream of farmers and 4c per pound butterfat more is paid for sweet than for sour cream, all the farmers will soon deliver cream of the first grade, although it is absolutely necessary to continue the cream grading every day of the year because some of the patrons will occasionally drop back into second grade cream class and they should be paid for this grade of cream.

Confidence in the Grader. One of the first things to do in introducing milk and cream grading at a factory is to establish confidence in the minds of the farmers that their product will be graded honestly and by a standard which they approve. The profits from the business, both to the factory and to the farmers, will be greater when a comparatively small amount of good milk or cream is obtained and made into butter or cheese than at a factory where one price is paid for all kinds of milk and cream and they expect to make the business profitable on the basis of the total volume of business done rather than the quality of the product manufactured.

Some of the Grader's Duties. In grading either milk or cream, the man responsible for determining the grade

should be the first one to take the cover off each can. The air in the can under the cover gives a good indication of any taint or volatile and objectionable odors.

Another good way to locate some particularly objectionable flavor which may have developed in the butter or cheese is to take a small sample of each lot of milk or cream, place it in a glass jar and warm the sample by placing the jar in warm water having a temperature near 100° F. The odor of the milk or cream at this temperature will easily show which lot is responsible for the objectionable flavors that have been noticed in the factory product.

In those factories where milk and cream grading has been established, it has been found helpful to have on hand a sample of first grade milk or cream to show the farmer patrons who may come to the factory, especially to those who bring a second-grade product, as a comparison of each can received with a first-grade sample, will often be more convincing to the farmer than discussion.

The statement has been made that there should be but one grade of milk or cream, that is, the best grade, and all other milk and cream refused at the factory. Such a practice, if applied to all of our food products, would certainly bankrupt the grain farmer, the fruit farmer, the vegetable grower and the florist, as well as the milk producer.

Government Inspection. A number of times in years past it has been suggested that butter and cheese manufacturers should be supervised by United States or by State inspectors, and that these important food products deserved the same service that is now handed the public by the Government meat inspectors.

Certainly the public health needs the same supervision of its dairy products as it has of its meat supply, and although it costs a lot of money, I am sure no one would advise abolishing the present system of meat inspection because of its cost.

We have a precedent for this kind of inspection and supervision which the Government makes of the factories where "Navy" butter is made. In this case the Government not only furnishes the regulation or standards of the cream to be used in making navy butter, but it also requires the presence

of a Government official in the creamery where such butter is made, and the duties of this official are to watch the details of the daily operations of the factory and know that the requirements for making navy butter are followed in every detail each day.

A further illustration of the part which Government and State inspectors are now taking in the manufacture and sale of butter and cheese is the system adopted in our large cities of appealing to an official inspector on each market for a grade certificate on each shipment of butter or cheese bought and sold.

Grade the Dairy Manufacturing Plants. Although it is impossible to have a government inspector in each one of our factories throughout the country, the operators of these should all be competent to grade the milk and cream they receive and to make a product of the best quality when they receive the best grade of milk and cream. The question then arises as to what shall be done with the second grade milk or cream, which at most factories is a small percentage of the total received.

It has occurred to me that it is possible to select one factory in a certain neighborhood as the factory to which all second grade milk and cream may be sent; then have a government or state inspector stationed at this factory for the purpose of supervising the manufacture of the dairy products from this second grade milk or cream and also the disposing of them in some way to be worked out as most appropriate for selling such second grade products.

By establishing these second grade factories, or those in which second grade products are made, two things at least will be accomplished:

First: The factories grading their milk or cream will have a place to which their second grade supply may be sent.

Second: The milk and cream producer who persists in careless methods that are sure to produce second grade milk or cream will be paid accordingly, that is, second grade farm products will not be mixed with the first grade and thus depreciate the quality of the entire product made at the factory.

We have a precedent for this suggestion of shipping all second grade milk and cream to one factory in a given district in the present practice of making renovated butter.

The renovated butter factory is carefully supervised by a government inspector, the product made is carefully labeled and sold entirely on its merits. This renovated butter is made from small quantities of butter that have been bought at some general store in the country where farmers trade farm butter for other products. The storekeepers are often obliged to keep this butter until it spoils or until they are obliged to get something for it, and then it is sold to a renovating factory.

This same plan could in my opinion be adopted for making other dairy products from second grade milk or cream.

We Progress Slowly. It sometimes takes a long time for even a good idea and a profitable practice to make a serious impression on the majority of the people who ought to be most interested in it.

Think for a moment how many years it took to introduce the practice of paying for milk and cream by the test; also to introduce the practice of pasteurization of milk and cream, the centrifugal cream separation, the cow testing association, modern ice cream making, delivery of milk in bottles instead of a two-gallon can and a quart dipper, standardizing the composition of butter, etc., etc.

Such important improvements progress slowly; their value is easily understood immediately by a few of the milk and cream producers, but it takes a long time for the main part of the procession to catch up with the leaders.

Grading Milk and Cream by the Acid Test

The Farrington Alkaline Tablets may be used for preparing an acid testing solution of any strength. These tablets contain both the alkali and the indicator, so that all one needs to do is to dissolve them in distilled or clean, rain water. A certain number of tablets added to a measured quantity of water will give an alkaline solution of any strength.

By dissolving five tablets in 97 c.c. of water a solution is obtained for testing the exact acidity of any lot of milk or cream. One c.c. of this solution represents .01 per cent acidity when a 17.6 c.c. pipette full of milk or cream is measured into the testing cup. The 17.6 c.c. pipette is the one used for measuring milk into Babcock test bottles, and nearly every dairy manufacturing plant has one of these pipettes on hand. If, in addition to this, a 100 c.c. graduated cyl-

inder, costing about fifty cents, is obtained, it will be an easy matter to make an acid test at any time. Five alkaline tablets are added to the cylinder, it is filled to the 97 mark with clean rain water, and after closing the cylinder with the palm of the hand it is shaken until the tablets dissolve, making a pink testing solution.

By pouring the pink liquid, a little at a time, into a measured quantity (17.6 c.c.) of the milk or cream in the cup, it will be noticed that the pink color of the tablets disappears at first, but after a time the pink solution will color the milk or cream in the cup. When the first permanent pink color remains in the milk or cream the test is completed.

The number of c.c. alkaline tablet solution used in each case shows the acidity of the sample tested. If 15 c.c. of tablet solution has been added, this means that the sample of milk or cream contains .15 per cent acidity. If 32 c.c. of tablet solution has been required to produce the pink color in the milk or cream, this shows that the sample contains .32 per cent acidity.

These tablets will keep indefinitely; their standard strength does not change any more than salt changes by standing in a dry place. The strength of the solution made by dissolving the tablets in water will not change, although this is not the case with some of the alkaline solutions such as tenth normal sodium hydrate used in making the so-called Mann's Acid Test.

The tenth normal alkali solution, or Mann's Acid Test solution may be made with the tablets by dissolving 24 tablets in 100 centimeters of water, and any other alkaline solution of a definite strength may be made by dissolving these tablets in water, using a certain number of tablets for a measured quantity of water.

Rapid Testing of Many Cans of Milk or Cream

In grading milk and cream at the factory these tablets have proved to be especially adapted to rapid work such as testing each can of milk and cream for acidity at the time it is weighed in or received. This rapid testing may be done in the following way:

Dissolve sixty-four Farrington alkaline tablets in one quart of clean, soft water (one quart equal to 946 c.c.), or 68 tablets into 1,000 c.c. of water. A one or two-quart Mason jar is convenient for dissolving the tablets as it has a wide mouth through which a small quantity of the liquid may be dipped out. The tablets will all dissolve by shaking them in the water, except a white, sandy residue, which settles to the bottom of the jar.

Apparatus Needed: Besides the tablet solution, prepared as above, all that is needed for making the test is a coffee cup and two small tin cups made by soldering a wire handle to a No. 10 cartridge shell or to a tin dipper about one inch deep and three-quarters inch in diameter.

Operating the Test: As each can of milk or cream is poured into the weigh can, or after it has been thoroughly mixed, one of the small dippers full of the milk or cream is emptied into the white cup.

The other dipper of the same size is filled with tablet solution, and this is poured into the milk or cream already measured into the coffee cup. The two liquids are mixed by a slight rotary motion of the cup, and the color of the mixture observed. If a pink color remains after thoroughly mixing, it indicates that this lot of milk or cream contains less than .2 per cent acidity. If the pink color entirely disappears, it shows that this can of milk or cream contains more than .2 per cent acidity. The sweeter the milk or cream the darker the pink color in the cup.

By testing each can of milk or cream in this way they may be divided into first and second grade, provided the standard of .2 per cent acidity has been agreed upon as milk or cream of the first grade.

In case some other standard of acidity is desired, each can of milk or cream may be measured by this standard if more tablets than two to one ounce of water are used for making the solution. As a rule, however, .2 per cent acidity is generally accepted as the dividing line between first and second grade milk or cream, such as milk and cream to be used for pasteurizing in a city milk plant, milk used for making cheese at a cheese factory, and sweet cream for ice cream making or buttermaking. This amount of acidity can not be detected by the sense of smell or taste, but the rapid method of

testing with the alkaline tablet solution will show at once whether or not the can of milk or cream is above or below this standard, or is sweet enough for bottled milk, for ice cream, or for making the best quality of butter or cheese.

The Fat Test of Sweet and Sour Cream

The statement is occasionally made that sour cream tests more than sweet cream, and it is also reported that some cream buyers tell the farmers that if they let their cream stand and ship it only once a week they will get a higher test than if they sold sweet cream.

This statement that sour cream tests more than sweet cream is doubtless based on opinion only, probably inferred from the fact that sour cream looks thicker than sweet cream because of the coagulation of the casein. Sour cream is more difficult to mix for taking a fair sample than is sweet cream, and in some sour cream samples small lumps of butterfat may be churned out and are accidentally added to the test bottle when the sour cream is tested. This, of course, would increase that one test. No one has ever demonstrated by making comparisons that sour cream does test more than sweet cream.

The following data has been collected for the purpose of getting some information about the effect that excessive souring may have on the test of both milk and cream.

Testing Sour Milk

A sample of sweet milk was measured into sixteen Babcock test bottles. These were placed on a shelf in a warm room where the temperature ranged between 80 and 90° F. Two of these bottles were immediately tested while the milk was sweet, and both tests were found to be 3.6 per cent fat.

After three days, two more of these bottles were tested in the same way as the first two bottles, and this sour milk in both cases tested 3.6 per cent fat.

After the end of one week two more of these bottles were taken from the shelf, sulphuric acid added to the milk, the test completed as usual, and both tests read 3.6 per cent fat. The remainder of the bottles were allowed to stand on the shelf until the milk in them was three weeks old. This milk

had soured, turned brown, and moldy in the bottles, but at the end of this three weeks we added acid to four of these bottles in the same way as we would have done if the milk had been sweet, and in every case a good separation of the fat took place and a test of 3.6 per cent was obtained.

This shows conclusively that souring of milk does not change the fat sufficiently to change its test. Any change that may be observed in the test of sour milk, which may be lower or higher than the test of the milk, when sweet is caused by the difficulty in mixing the coagulated curd with the whey and of getting a uniform sample of the sour milk.

If the milk is measured sweet into test bottles and these test bottles are allowed to stand in a warm place for days and even weeks until the milk is sour, it will be found that by adding acid to such milk in these test bottles and completing the test in the usual way, the same per cent of fat will be found in sour as in the sweet milk.

Testing Sour Cream

A sample of sweet cream was measured with a pipette into each one of twelve test bottles. Two of these were tested at once, and the result obtained was 31.0 and 31.5 per cent fat.

After three days two more of these bottles were tested and the results obtained were 31.7 per cent and 31.5 per cent fat.

After one week, two more were tested with the same results, both testing 31.5 per cent fat. At the end of the second week, two of these test bottles were taken from the shelf, acid added, and tests made in the usual way, with the result that both tests showed a reading of 31.5 per cent fat. The same thing was done with the cream in the test bottles when three weeks old, and the test was 31.5 per cent fat just the same as it was when sweet.

Cream Allowed to Sour in the Farmer's Can

It is possible that when a can of cream is held at the farm for a week and small portions of cream are added to this can each day, there may be some evaporation of water from the can and this will concentrate it somewhat. This evaporation, however, is probably not sufficient to increase the test of the cream, provided a fair sample is taken at the time it is tested.

There are certain localities where farmers do not deliver their cream to a buyer every day, but, after separating the cream from the milk at each milking, pour the cream into a can and let the can stand until it is delivered to the cream hauler, or possibly to the railroad station.

A few observations were made at our creamery to note the changes in test that may take place when cream is allowed to stand in a five-gallon can as would be the case on the farm.

Three five-gallon cans were partially filled with cream. Two of these cans were covered loosely by placing the cover on the top of the can, while the other can was not covered. The three cans were then placed in a warm room where the temperature ranged from 80° to 90° F. Each of these three cans of cream was weighed every few days and a sample of cream taken for testing. This was continued for three weeks, during which time the cream in all the cans became very sour.

Results showed that in each of the cans of cream allowed to stand with the cover on the can, the weight did not decrease or the test of the cream change.

The third can of cream, which was allowed to stand uncovered during the three-week period, was weighed and tested every few days in the same way as the other cans of cream.

During this period the can which was left with the cover off lost one pound in weight (from 29.2 pounds to 28.2 pounds), and the test of the cream changed from 34.0 per cent fat, when sweet, to 35.5 per cent when sour.

Deducting the weight of the can, which was 12 pounds, we had 17 pounds of sweet cream. This multiplied by the sweet cream test, 34 per cent fat, gives 5.85 pounds butterfat in this can of sweet cream.

Making this same calculation on the can of sour cream we have 28.2 pounds sour cream less can weight, 12 pounds, gives 16.2 pounds cream. This multiplied by the test of this sour cream, 35.5, gives 5.75 pounds butterfat in this can of sour cream. These figures show that the test of the sour cream increased 1.5 per cent, but the weight of the cream diminished one pound. The calculations show there was a loss of .1 pound butterfat available to sell in the can of sour

cream, although the test of the sour cream was higher than when the same cream was sweet.

Selling Sweet and Sour Cream

When milk is separated at the farm immediately after milking, the cleanest and sweetest cream possible ought to be obtained. If this cream is cooled at once to near 50° F. and provision is made for keeping it cold until delivered to the buyer, an excellent quality of butter or ice cream can be made from it.

There is a good demand and a good price paid for sweet cream, which may be easily produced on any farm where cows are kept, by noting the following suggestions:

1. Place the cream separator on a firm foundation in a clean, well ventilated room, where it is free from all offensive odors.

2. Thoroughly clean the separator after each skimming. The bowl should be taken apart and washed, together with all the tinware, every time the separator is used. If allowed to stand for even one hour without cleaning and then used again, there is danger of contaminating the cream from the sour bowl. This applies to all kinds of cream separators.

3. Wash the separator bowl and all tinware with cold water and then with warm water, using a brush to polish the surface and clean out the cream from cracks. Finally scald with boiling water, leaving the parts of the bowl and tinware to dry in some place where they will be protected from dust. Do not wipe the bowl and tinware with a cloth or drying towel. Heat them sufficiently with steam or boiling water so that wiping is unnecessary.

4. Rinse the milk receiving can and separator bowl with a quart or two of hot water just before running milk into the separator.

5. Cool the cream as it comes from the separator, or immediately after to a temperature of about 50°, F. and keep it cold until delivered.

6. Never mix warm and cold cream, or sweet and slightly sour cream.
7. Provide a clean, covered water tank for holding the cream cans, and change the water frequently in the tank, so that the temperature does not rise above 60° F. A satisfactory arrangement may be made by allowing running water to flow through the cream tank to the stock watering tank.
8. Skim the milk immediately after each milking. This will take less work and be more satisfactory than to hold the milk from one milking to the next. When separated but once a day, the milk held over has to be heated to a temperature of that freshly drawn.
9. A rich cream, testing 35 per cent fat or more, is most satisfactory to both farmer and buyer. The best separators will skim a rich cream as efficiently as a thin cream and more skim milk is left on the farm when the rich cream is sold.
10. Cream should be perfectly sweet, containing no lumps or clots, when sampled and delivered to the haulers or parties buying it.

Butter and Cheese Standards

When butter and cheese are sold in the larger markets, their quality is indicated by a certain standard score based on 100 as representing perfect in all the classified points.

The general practice of judging both butter and cheese is about the same and the following statements about butter apply to cheese to some extent.

A large proportion of the butter bought and sold ranges between the figures 93 and 87. Butter scoring 94, is the highest quality of butter for which a market quotation is given.

The difference in the prices quoted in the market reports for butter scoring from 87 to 93, usually varies about one cent per pound for each point in the score. If butter scoring 93 is quoted at 50c, then butter scoring 92 may be quoted at 49c, butter scoring 91 at 48c, butter of 90 at 47c, butter of 89 at 45c, butter scoring 88 at 44c, and butter scoring 87 at 43c.

About the only variations from this one point in score representing 1c per pound difference in market quotations is the price of butter scoring 90, which is usually about 2c higher than the price quoted for butter scoring 89.

In grading butter for the purpose of determining its price, the butter judges and the butter buyers have adopted various expressions or words which are quite commonly used in defining the difference in the quality of butter of different grades.

The following table shows an arrangement of these words and expressions. It is a condensed form of a similar statement given in Circular No. 51, of the U. S. Department of Agriculture, Bureau of Markets, describing the inspection of butter under the food products inspection law.

Words Used in Butter Scoring

Total Score	Flavor Score	Words used to describe Flavors						Workmanship[1]
94	39	Fresh	Fine	Sweet	Mild[2]	Clean	Creamy	Perfect
93	38	Fresh	Fine	Sweet	------	Clean	--------	½ point off
		------	Fine	Sweet	------	Clean	Storage	
92	37	Fresh	------	Sweet	------	Clean	--------	
		------	------	Sweet	------	Clean	Storage	1 point off
91	36	Mechanical taints: (Cooked, oily, fruity in storage, mealy, greasy) Bacteria taints (Cowy, acidy, yeasty) Feed taints (Weedy, frosted feed)						Slightly wavy
90	35	Metallic, wintry, bitter ("Old" in storage)						Slightly weak, wavy, gritty
88	33	Unclean, musty, limy or alkaline						Weak, mottled, gritty
87	32	Garlic or wild onions, "off," fishy, tallowy, unclean, stale or gasoline						Defective but not rancid
84	29	Slightly rancid						Slightly rancid, mottled

[1]This includes the body 25, color 15, salt 10, package 5.
[2]If ripened may have clean starter flavor.

In arranging the words in this table an attempt has been made to simplify the expressions ordinarily used in judging butter and to discuss only those grades of butter which are usually mentioned in the daily butter market quotations.

It will be noticed that butter scoring 94 is given a flavor score of 39, and that the adjectives commonly used to describe the flavor of such butter are fresh, fine, sweet, mild, clean and creamy, and that the workmanship, which includes the texture or body of the butter also its color, salt and package, is perfect.

When it comes to butter having a total score of 93, the flavor score is 38 and the adjectives describing the flavor are the same as those describing the flavor of butter scoring 94 except that the two words "mild" and "creamy" are omitted, and further, a certain defect in workmanship, which totals not more than one-half point, is permitted in this grade of butter.

Butter scoring 92 has a flavor score of 37, but the adjective "fine" is omitted in describing the flavor of this grade of butter and the workmanship defect may amount to so much as one point.

The further use of certain adjectives and expressions describing the quality of butter scoring less than 91 is shown in the table; and if such a classification could be universally adopted by all judges and all buyers of butter, it might be possible to get a more uniform grading of butter, especially if it can be generally agreed that any lot of butter having the various flavors here mentioned and the defects in workmanship also, would immediately be classified according to the grade mentioned in the table. For example, if a lot of butter is slightly wavy in color, this will prevent it being classed in in any grade above 91 and if the butter has a gasoline flavor this would put it in the grade of 87.

It is of course true that the market demand for butter will have more or less influence on the grade in which it may be placed, but in so far as it is possible to do so, this classification of the various words commonly used in discussing the quality of butter may be helpful in classifying these expressions and in giving a better understanding of the reasons why butter is placed in a certain grade and sells for a certain price.

Butter Flavor. A greater number of words have been used to describe the different flavors of butter than for any other quality, and some of these have been arranged as shown in the table.

Butter Body and Texture. When a package of butter is considered perfect in body and texture the words commonly used to express this perfect condition are firm, waxy, and like a broken steel edge.

Whenever a piece of butter has this kind of a texture, the full value of 25 points is generally given to it, but if the butter shows a stringy body or it has an excess of moisture or a milky brine, the score on body is usually reduced at least one point.

Butter Color. The perfect color in butter may be either a light straw or a medium yellow color, which is noticed in June or grass butter. This color should also be solid and uniform.

The score on color of butter is reduced below perfect when the butter has an excessively yellow color, or is slightly wavy or mottled. When these defects in color appear, the score is reduced one point or more, depending on the extent to which these defects are present.

Butter Salt. When butter has a decidedly briny, or bitter, salty taste, and an analysis shows it to contain an excessive amount of salt, such butter may be scored off one point on salt.

Butter Package. The full score on "package" of 5 points is given when it is neat, clean, has no ragged edges, and is made of strong material. Any appearance of mold on the packages; or lack of uniformity, in case a shipment contains many packages; or the use of unsound wood or other faulty material in making the package should reduce the score on package by at least one point.

Difference in Value of Butter Qualities. The extent to which the various defects in butter reduce the score varies somewhat with the quality of the butter in which these defects appear. If a package of butter which is nearly perfect in flavor should happen to have a milky brine or a gritty salt taste, these defects would reduce the total score of this

package of butter at least 6 points, and if they occurred, in butter which might be worth a score of 94, such defects would reduce the score to 88.

If, on the other hand, the flavor of butter was such that it could be given a score of 90, these defects of milky brine and gritty salt would not reduce the score over 3 points, making the total score 87.

It is customary in buying butter to give slightly different values to the defects, depending on whether they appear in a perfect butter or in a butter of average quality.

Relation of Fat Content of Butter to Its Quality

It is natural to assume that the higher the percentage of fat in butter, the richer and better the quality of the butter, even though the per cent of fat may not vary more than 5 per cent.

As a rule the per cent of fat in butter runs from 80 per cent to 84 per cent.

It has been repeatedly shown that butter of poor quality may contain so high as 85 per cent fat, and butter of the finest quality may contain so low as 80 per cent fat. There seems to be no uniform relation between the per cent of fat in the butter and its quality as is shown by the following figures taken from the scores and analyses of over 300 packages of creamery butter:

Butter Score	*Fat Per Cent Average*
85–86	83.20
86–87	81.25
87–88	82.14
88–89	82.28
89–90	83.23
90–91	81.66
91–92	82.03
92–93	82.23
93–94	83.65
94–95	83.20

Some of this high testing butter had a high quality and some of it a low quality score, showing no uniform relation between fat content and quality in butter.

Butter and Cheese Judging

The judging or scoring of butter and cheese may be done for the purpose of:

1. Buying and selling these products on the basis of certain market standards and quotations.
2. Learning how to improve the quality of the butter or cheese. (Educational purposes.)
3. Awarding premiums or prizes in competitive exhibitions.

As a rule the highest scores on butter and cheese are given by judges officiating at a competitive exhibition. In such cases entries are made with the expectation of receiving a premium or prize money at a State Fair, County Fair, Dairy Show, Buttermakers' or Cheesemakers' meeting.

On these occasions the judges ordinarily have to score all the way from ten to several hundred entries, and while they have a certain standard in their own minds and score according to these standards, the indicated quality of the butter or cheese as measured by these standards is usually a little higher than the score the same butter or cheese would receive if sent to a merchant, who buys it on the basis of the quality that suits his customers.

It will be noticed that if butter or cheese is shipped to a large market and a request for a score of it is made by the maker or by parties owning the butter or cheese, the scores returned by the official market judge will vary from one shipment to another but very little. In fact, the market judge generally scores most of the butter or cheese between the figures 89 and 92, while the judges at the State Fair or Convention or Dairy Show may have a much wider range in their scores, say from 86 to 96.

In scoring butter or cheese for educational purposes an effort is usually made to give considerably more time to the judging than it seems to be possible for merchant judges or exhibition judges to take. The educational judge tries to give consideration to the texture, the color and the salt, as well as to the flavor of the product, and these are points that need the attention of the buttermaker and the cheesemaker because he is usually responsible for the so-called "workmanship" defects.

The educational feature in judging can be of great assistance to the makers themselves and to their patrons if they will pass along the information given by the judge to their patrons.

One of the most helpful exercises for butter or cheese improvement that every maker can promote is to invite the buttermakers or the cheesemakers from his neighboring factories to each bring a jar of butter or package of cheese to the town hall or school house, and then invite all the patrons of all the factories to be present and talk over the qualities of the different exhibits. This will give the patrons an opportunity to note the variation in the product made at the different factories and help to show the effect of farm and factory conditions on the quality of the butter and cheese made at the different creameries and cheese factories.

This has been tried in certain localities and found to be very helpful, especially if the farmers bring their wives to see and to hear these discussions. It is surprising to see what a revelation it is to all interested parties to find that there is such a difference in the quality of the product made at the factories in the same neighborhood when packages from all the factories are placed together on a table and the patrons, including the women folks, are given a chance to inspect the butter and cheese themselves.

No better way of improving the quality of the product at our creameries and cheese factories can be tried than to hold a picnic or a gathering of the patrons in a given locality and let the patrons inspect the butter and cheese from the different factories. Such an inspection will be very helpful to the maker in his attempt to improve the quality of his product, as his work at the factory is likely to be only a part of the cause of the good or bad product made at that factory.

Creamery buttermakers and factory cheesemakers should, therefore, keep in mind the three types of judges that may pass on their product, that is, the merchant, the convention judge, and the educational judge. Each one of these judges may have the same score card or points as his standard, but his acquaintance with butter and cheese is not the same and his object in scoring them is likely to be a different one also. These facts should be given due consideration when a judge's score is received.

CHAPTER I

The Cause, Prevention and Remedy for Defects in Butter

The standard score card by which the quality of butter is judged at the present time gives 45 points to flavor, 25 to body or texture, 15 to color, 10 to salt, and 5 to package, total 100.

These figures show that the flavor of butter is by far its most important quality. In fact, fully 90 per cent of the losses in selling butter are due to flavor defects, and most of these can be prevented.

The suggestions here given are designed as a guide for the busy buttermaker to use in quickly locating the probable cause of the butter defects and to help him apply the remedy or prevent a further loss from such defects in the future. In other words, this discussion is an attempt to give as briefly as possible, and at the same time instructively, some helpful suggestions concerning the difficulties buttermakers may have in keeping butter up to a high standard of quality and to outline the course they may pursue in trying to overcome such defects as are noticed by butter judges or by butter buyers.

Comments will be made on each defect in flavor, body, color, salt, and package, but naturally the principal part of the discussion will be confined to the defects in flavor which are likely to need the most attention of the buttermaker.

The various defects have been arranged alphabetically to aid in quickly finding the one sought. Not all the causes mentioned in the discussion of each defect may be found responsible for it, but some one of them is probably an important factor, and it is up to the buttermaker or the farmer to remove that particular one in each case.

"Acidy" Flavor in Butter

"Acidy" flavor in butter may be caused by:

1. Over-ripening of the cream before churning.

2. The use of an over-ripe starter.

3. Cream too sour when received from patrons.

Remedy: Extensive experiments have shown that butter made from excessively sour cream does not keep well, and further that it has a tendency to become fishy when placed in storage. In order to prevent losses from butter having an "acidy" flavor, it is necessary to insist on patrons delivering cream to the factory before it gets too sour. This may be done by frequent delivery, at least every other day, or if the farm has a place where cream can be kept cold in clean cans so that it does not sour before delivery, it is possible to keep the cream several days before sending it to the factory.

The age of the cream is not so much the cause of "acidy" butter as the temperature of keeping the cream before it is delivered to the factory, and the cleanliness of the pails, cans and the farm cream separator.

The cream should be churned before it reaches an acidity of .5 per cent or in case a very sour cream is received at the factory this should be neutralized down to about .2 per cent acid before it is pasteurized and churned.

Do not mix sour cream containing over .4 per cent acid with sweeter cream and churn the mixture, as the excessively sour cream in the mixture will have a tendency to give the butter an acidy flavor.

Barny or Cowy Flavor in Butter or in Cheese

Barny or cowy flavor in butter or in cheese may be caused by:

1. Poorly ventilated cow stables, especially in winter time.

2. Unclean udders and flanks of cows at milking time.

3. Leaving the cans of milk in the stable during and after milking.

4. Failing to cool the milk and the cream to 50° F., or lower.

5. Using a cream separator in the cow stable.

Remedy: The so-called putrifactive bacteria are especially numerous in the air of a cow stable where the dust from feed, bedding, etc., accumulates and there is not good ventilation. These bacteria find their way into the milk pail and later develop in milk the characteristic "barny" flavor.

The effects of these bacteria may be diminished by immediately cooling the milk after milking and especially by never mixing old milk and new milk. The warm milk or warm cream should always be cooled to the temperature of the milk or cream into which it is to be poured, in case two lots are mixed.

The practice of filling milk cans in the cow stable as fast as the cows are milked is responsible for many defects in butter, and cheese especially the "cowy" and "barny" flavor in these products. This may be easily prevented by carefully cleaning the cows before each milking, and by removing the milk at once from the cow stable to a clean milk house.

Never keep cans of milk or cream near a manure pile or in the stable, but hold these cans in cold water in a well ventilated place.

Bitter Flavor in Milk, Butter or Cheese

Bitter flavor in milk, butter or cheese may be caused by:

1. Allowing the milk or cream to freeze in winter, or by holding the milk and the cream too long a time at a low temperature near freezing.
2. By cows late in their milking period.
3. By feeding certain lupines, ragweed, beet tops, and dry pasture in excess.
4. By using salt which is not pure, since some of the chemicals in impure salt have a bitter flavor.
5. By over-neutralizing the cream, especially when lime is used as a neutralizer.

Remedy: The cooling of milk and cream at the farm is always recommended, and the sooner this is done after milking or separating, the better the quality of the product made from such cream, but since certain bacteria that pro-

duce bitter flavor in milk and cream may grow at a temperature near freezing, it is necessary to protect these from too cold a temperature for any length of time. These bacteria may find their way into the milk from the dust in the air during milking time, and they will develop rapidly at near-freezing temperatures.

If bitter milk or cream is received, this should not be mixed with the supply of good milk or cream, but made up separately.

Only the best and purest salt should be used for salting the butter or the cheese and if the cream is neutralized in the process of buttermaking, the neutralizer should be carefully selected.

If a starter is used in ripening the milk or the cream, it is advisable to taste the starter before adding it to the cream or to the cheese vat of milk, especially during the Winter season. A small amount of starter added at a temperature of 60° in the Winter is better than a large quantity of starter when it has a temperature of about 50° F. and is held at this temperature or lower.

Keep the cows clean, so that the bitter flavor germs do not get into the milk during milking.

Coarse Flavor in Butter

Coarse flavor in Butter may be caused by:

1. Over-ripe cream.
2. Over-ripe starter.
3. Excessively high salting of the butter.

Remedy: Either churn the cream sweet, or neutralize the sour cream down to about .2 per cent acidity.

Carefully inspect the starter when it is used, and, if salted butter is made, be sure and work the butter sufficiently to dissolve and to distribute the salt evenly through the entire mass of the butter.

Coloring Butter with the Salt

The buttermaker sometimes forgets to add the usual amount of color to cream before churning and finds when the butter comes that it is lighter colored than he wants it.

In such cases, the desired amount of color, which should have been added to the cream, may be mixed with the salt. The colored salt is then added to the granular butter in the way the buttermaker is accustomed to salt his butter and it will be found that this colored salt will distribute the color through the butter although at first some streaks or unevenness in color may be noticed. This unevenness will disappear after the butter has stood for a while in the package.

A little more care is needed in working a colored salt into the butter than the uncolored salt, but it is possible to make the operation entirely successful and get an even colored butter in this way.

In some localities the butter trade wants a so-called "June" butter color during the entire year, while other sections of the country want butter with a very light color, though never white.

When cows first go to pasture the shade of yellow color in their butter becomes deeper than during the winter when the cows are stable fed.

At the season of the year when the milk fat from which butter is made has its highest natural color, from 5 to 10 c.c. butter color per hundred pounds of fat in the cream may be used.

During the winter, or dry feed season, as much as 40 c.c. of butter color per hundred pounds of butter fat in the cream is sometimes needed to supply butter of the color desired.

The amount of color used at any time during the year must be determined by the judgment of the buttermaker.

Some feeds like clover hay have a tendency to increase the yellow color of butter, while other feeds like straw and roots when fed to cows reduce the yellow color in the butter somewhat.

It is also claimed that the milk of a fresh cow makes butter of a deeper yellow color than the milk of the same cow when she is nearly dry.

Cooked Flavor in Butter

Cooked flavor in butter may be caused by:

1. Failing to cool the cream quickly enough after separating it at the farm.

2. Heating the cream too long a time at a high temperature during the pasteurizing process.

3. Failure to wash the granular butter with enough cold water.

Remedy: Cool the cream at the farm or wherever it may be separated to near 50° F. immediately after it comes from the cream separator; allow the cream to stand at this temperature until it is delivered to the buyer or to the churn.

The milk need not be heated to a temperature much above 85° F. for skimming, or the cream heated to a temperature much above 145° F. for pasteurizing.

Any method of heating that has a tendency to coagulate the curd in the milk or cream, will help to give a cooked flavor to the butter if this curd is allowed to remain in the butter, but if carefully washed out of the granular butter with cold water, and repeated washing, the cooked flavor will disappear. In fact, by keeping butter with a cooked flavor in a refrigerator for a day or two, this flavor may disappear entirely.

Crumbly Butter

Crumbly butter may be caused by:

1. Too many stripper cows in the herd.

2. A dry feed ration.

3. Churning a very rich cream at a very low temperature.

Remedy: The feed cows receive has a distinct effect on the softness and the hardness of the butterfat in their milk. The hard milk fat makes a hard butter; Green feed, such as pasture grass, silage, and green forage of any kind, have a tendency to make butter soft, and if at any time the butter buyer complains of the texture of the butter, this may probably be overcome by increasing or decreasing the green feed of the cows producing the milk.

Another way of overcoming the crumbly body of butter is to increase the number of fresh cows in the herds producing the milk, as the butterfat of the milk of a cow late in her

milking period contains more hard butterfat than is found in the milk fat of a fresh cow.

It is a comparatively easy matter to determine the cause of crumbly butter in any case as it is not often due to the method of ripening the cream or of working the butter. It is almost entirely caused by the feed of the cows and the number of stripper cows in the herd from which the milk and cream is received. By equalizing the feed, that is, giving more green feed in case the butter is crumbly and by increasing the number of fresh cows in the herd, this condition of the butter may be avoided.

Curdy or Cheesy Flavor in Butter

Curdy or cheesy flavor in butter may be caused by:

1. Churning very thin, sour cream in which the curd has already coagulated.
2. Using a starter that is too sour.
3. Ripening a thin cream at too high a temperature.
4. Leaving too much buttermilk in the butter.

Remedy: By increasing the richness of the cream it will contain less curd than a thin cream, and the butter will also contain less curd, especially if the churning is stopped when the granules are small and these are washed two or three times with clean, cold water.

The starter should never be so sour that it has wheyed-off at the time it is added to the cream, and the temperature of holding the cream should be no higher than 65° F. during the ripening process. This will keep the curd of the starter so soft that it may be easily washed out of the granular butter when the churning is completed.

In case it is not possible to get a rich cream, that is, cream testing 30 per cent fat or more, a thinner cream should be ripened at a low temperature, say not higher than 60° F., and cooled to near 50° F. when churned.

Dull Color in Butter

Dull color in butter may be caused by:

1. Over-working the butter.

2. An excessive amount of water in the butter.
3. Incorporating too much air in the butter when an effort is made to add more water to it.

Remedy: As stated under Mottled Butter, the size and the distribution of the drops of moisture in the butter have a great influence on its color. When these are unevenly distributed the color is not uniform; and further, by failure to mix the salt evenly through the butter an excessive amount of working is sometimes necessary, especially when a test shows that the butter has too much moisture. This is likely to give dull color.

The best way to avoid this is to churn the cream at a low temperature, around 52° F., then dampen the salt when adding it to the butter and work at intervals until the salt is evenly distributed, and the texture of the butter is not spoiled by the over-working.

Feed Flavors in Butter and other Dairy Products

Feed flavors in butter and other dairy products may be caused by:

1. Lack of ventilation in the cow stable.
2. Using the refuse from feed troughs for bedding the cows.
3. Feeding the cows during instead of after milking.
4. Failing to remove the cans of milk from the cow stable immediately after milking.
5. Failing to aerate and cool the milk.
6. Skimming the milk in the cow stable.
7. Leaving the cans of milk or cans of cream near a pile of feed or in a feedroom atmosphere before delivery to the buyer.

Remedy: It is a comparatively easy matter to prevent contamination of either milk or cream by any feed except weeds. The flavor of weeds, garlic, and wild onions, will pass through the cow's system into her milk, while nearly all other

feed flavors if noticed in the milk, have probably been absorbed after the milk was drawn from the cow.

Many years ago, objection was made to feeding silage to cows because it was claimed the milk had a silage flavor. This was undoubtedly true, but at the present time we know that silage is one of the best milk producing feeds a dairy farmer can give his cows and that there is no need whatever of allowing this silage flavor to get into the milk or the cream.

Ventilation of the cow stable will remove the silage flavor from the building, and feeding silage after milking as well as cleaning up the refuse silage and removing it from the cow stable instead of using it for bedding, will protect milk from a silage flavor.

Milking the cows and skimming the milk with a cream separator located in a well ventilated place, as well as cooling and aerating both the milk and the cream and removing these from the cow stable will protect both milk and cream from silage or any other feed flavor. These are usually absorbed from the atmosphere after the milk is drawn from the cow and do not pass through the cow's system into her milk.

Fishy Flavor in Butter

Fishy flavor in butter may be caused by:

1. Churning excessively sour cream.
2. Using rusty cans for transporting the cream from farm to factory or rusty cream vats and pipes at the factory.
3. Too much salt in the butter.
4. Over-working the butter.
5. Holding the cream at the farm or the cream-buying station too long a time before it is churned.
6. The introduction of iron or copper salts into the cream from cans, pipe, vats, etc., that are not well tinned.

Remedy: When sour cream is received, or is used in the manufacture of butter, each can of such cream should be

graded on the basis of its acidity at the time it is received. Butter made from first grade cream, that is, cream testing less than .4 per cent acidity, probably will not turn fishy. Butter made from second grade cream testing over .4 per cent acidity and up to .5 or .6 per cent acidity is likely to become fishy, especially if in addition to being sour, the cream comes in contact with metal not well covered with tin, and in addition to this the butter is over-salted or over-worked.

All cream delivered to the factory in rusty cans should be refused and all the utensils at the factory should be kept well tinned so that the metals, iron and copper, are not exposed to the sour cream. The cream cans should all be cleaned and dried before they are delivered to the farmers.

When butter is made from cream having a high acidity, this should be neutralized to about .2 per cent acidity and pasteurized. It should not be exposed to too much air during the heating and the cooling processes.

Recent experiments have shown that fishy flavor in butter comes from a chemical substance called lecithin. This is a normal constituent of butter, but when cream is exceedingly sour and comes in contact with iron and copper and the butter is mixed with an excessive amount of air by over-working it, this substance, lecithin, may be changed into trimethlamine, which has a very pronounced fishy flavor.

It has been found that bacteria may not produce trimethalamine in butter, although bacteria do develope high acidity in cream. An excessive amount of salt in the butter intensifies the fishy flavor. Brine is a good solvent for lecithin. Overworking the butter increases the air content; that is, it mixes a large amount of air with the butter, and this helps to make the trimethlamine which has the fishy flavor.

Pasteurization of the cream has a tendency to reduce fishyness. By pasteurizing, the lecithin of the butterfat, becomes less soluble and therefore less easily changed into trimethalamine. Pasteurization also changes the lecithin to some extent so that the products formed from it are lost in the buttermilk and in this way removed from the butter. As a rule, butter made from pasteurized cream contains less trimethelamine than butter made from unpasteurized cream.

Fishy flavor in butter is responsible for many losses to the creamery man and to the farmer, and these may all be pre-

vented by churning the cream before it is excessively sour. Butter for storage purposes should be made from comparatively sweet cream, while butter made from excessively sour cream should be placed on the market for immediate consumption before the fishy-flavor develops.

Flat Flavor in Butter

Flat flavor in butter may be caused by:

1. Churning a sweet cream and delivering butter to the consumer shortly after it is made.
2. Excessive washing of the granular butter.
3. Using a starter which has not soured.
4. Some feeds, such as cotton-seed meal, fed in excess, have a tendency to give butter a hard texture and a flat flavor.
5. Churning sweet cream from stripper cows.

Remedy: As the flavor of butter is due somewhat to the "volatile fatty acids" in the butterfat, these may be greatly reduced by excessive washing of the granular butter in the churn, leaving the butter more or less tasteless. Cold water especially has a tendency to remove the flavor constituents from butter fat.

The butter wash-water as a rule should not be more than 5° F. below the temperature of the buttermilk, unless the cream was churned exceptionally warm. In such cases the wash water may have a temperature near 50° F., as the butter will warm it up somewhat.

If the flat flavor persists after attempting to control it, by using warmer wash water and less washing, add a well ripened starter to the cream, and this will help to develop the butter flavor.

Salting has a tendency to bring out some of the flavor of butter, if it is not added in excess, so as to cover up the butter flavor entirely.

Garlic or Wild Onion Flavor in Butter

Garlic, or wild onion flavor in butter and other dairy products may be caused by:

1. Allowing the cows to feed in pastures where these plants grow.

Remedy: Since weeds often grow in patches, and garlic especially springs up early in the season, usually before most pasture grasses start, it may be possible to fence off that portion of the pasture where garlic or wild onions grow, and thus prevent the stock from eating these weeds.

If the garlic or wild onion plants are distributed all through the pasture, the contamination of the milk with these flavors may be prevented by pasturing the cows on some other field and turn the stock not giving milk on to the pasture where the weeds do grow.

If it is not possible to make the change suggested, the effect of garlic and wild onion flavor in the milk may be reduced somewhat if the cows are taken off the pasture three or four hours before milking, and during this time stable fed with silage or some feed which does not contain these weeds.

As a rule the trouble from garlic flavor in milk, cream and butter is short lived, as the plants do not grow during the entire season, but only the early part of it.

Sheep grazing in Winter and early Spring will often destroy these plants, and since the wild onion ripens in June and July, cows should not be allowed in the pastures where these plants grow at that season of the year.

Another good remedy for this flavor in dairy products is to plow late in the Fall the fields or pastures which are infested with these plants. By turning them under, it is sometimes possible to kill out the weeds.

Certain plant-poisons, such as coal tar creosote, may be sprinkled over the plants in the field when they are growing. This will kill the plants if one has time to give to this method of removing them.

It has been suggested that these flavors may be removed by blowing air through the milk when it is heated to a temperature of 145° F. This temperature has been found better than others because blowing air through milk at a lower temperature may churn the milk, and at a higher temperature may prevent the cream line from appearing on the milk if it is sold in bottles.

The Department of Agriculture at Washington has issued a bulletin describing experiments made on the removing of

onion and garlic flavors from milk by blowing air through it while hot. These experiments suggest that air should be blown from thirty to sixty minutes, depending on the extent to which these flavors happen to be present in the milk. Further information about this method may be found in bulletin 610, U. S. Dept. of Agriculture, Washington, D. C.

Garlic and wild onion flavors in milk, and cream, or butter and cheese, are volatile, and on this account many attempts have been made to remove them by blowing, airing, aerating or cleaning the cream; in fact a few years ago some firms made a decided effort to introduce into creamery practice a method of blowing air through the cream in order to purify it and to remove any objectionable flavors. The general conclusion from the use of these methods has been that the equipment needed for treating the cream is too expensive, and unless large quantities of cream must be treated, it is not a paying investment.

It is true that blowing air through milk or cream will remove some flavors partially, and patented arrangements for doing this under pressure or in a vacuum and at all kinds of temperatures have been proposed.

Recently a method has been suggested by which hot air is blown through a spray of cream. The cream must also be hot and have a low acidity. Further, the cream must be passed through the apparatus a number of times and by a continuation of the spraying and heating it has been found possible to remove most of such flavors as those imparted to milk, cream and butter by onions, garlic and other weeds.

One objection to such heating of the cream has been the development of a mealy texture in the butter. This, however, may be prevented by blowing hot air into the cream and then cooling it suddenly to as near 50° F. as possible. During this heating and cooling process the cream should be continually stirred and have not much over .2 per cent acidity. Reducing the acidity prevents the cream from curdling during the heating process.

During the past year a method of treating such cream by heating it in a vacuum has been suggested and the equipment needed for using this process is now placed on the market by dealers in dairy supplies. It should be remembered, however, that all these methods of treatment are ex-

pensive and probably will not be profitable except in large factories where a considerable quantity of such contaminated cream is received.

Gasoline Flavor in Butter

Gasoline flavor in butter and other dairy products may be caused by:

1. Using a gasoline engine for running the cream separator.
2. Skimming the milk with a cream separator in a room where gasoline fumes are noticeable.
3. Failure to extend the exhaust pipe from a gasoline engine high enough into the air to carry away the fumes from the building in which the milk and cream are held.
4. Allowing the milk or cream cans to stand in the same room or wagon with a gasoline can.

Remedy: Whenever a gasoline engine is used on a dairy farm where more or less milk or cream is produced, the machine itself must naturally be kept so thoroughly clean that there is no gasoline odor about it.

The exhaust pipe of the gasoline engine should be extended high enough into the air to carry away the exhaust gasoline fumes from the vicinity of the cream separator, the cow stable, the milk cans, or the milk utensils, which may be washed and left to dry on a draining rack.

Both milk and cream take up the odor of gasoline easily. Sometimes the farmer carries his cream to the buyer along with a gasoline can in his wagon or automobile, and when this is done the milk or cream may take on a strong gasoline flavor.

The greatest difficulty, however, cames from the exhaust gas of the gasoline engine; few farmers realize how easily this will penetrate the milk and cream and leave its flavor in these products or in the milk cans.

By keeping the gasoline engine thoroughly clean and by extending the exhaust pipe above the air around the milk house or the place where the milk and cream cans are kept,

there will be no danger of getting a gasoline flavor in butter or any other dairy product.

Greasy Butter

Greasy butter may be caused by:

1. Overworking the butter.
2. Working when the butter is too warm and too soft.
3. Too high churning temperature.
4. Too rich cream.
5. Allowing the butter to warm up in the churn before working.
6. Any treatment of the butter during the entire process of making, that tends to soften it.

Remedy: The cream should be held at a temperature near 50° F. or lower, a sufficient length of time to completely harden the butterfat in the cream before churning it. This will take at least two hours, and, if the cream can stand six to twelve hours at a cold temperature, the body of the butter will be good, provided the cream is not then placed in a warm churn.

The churn should be thoroughly chilled with cold water before adding the cream, and the churning done in a room where the temperature does not rise sufficiently to soften the butter during the churning or the working processes.

The wash water used, after drawing off the buttermilk, should never have a temperature of more than 55° F.; a temperature of 50° F. is preferred.

By churning the butter to granules about the size of wheat, drawing off the buttermilk at this point and filling the churn about one-half full with cold water, having a temperature near 50° F., the butter will not have a greasy body provided it is not warmed up after or during the working process.

The temperature of the buttermilk when churning stops, is the churning temperature. The temperature of the cream when it is placed in the churn is not, properly speaking, the

churning temperature, unless it corresponds to the temperature of the buttermilk when the churning stops.

Over-working warm butter is the most common cause of greasy body in butter.

Green Spots in Butter

Green spots in butter may be caused by:

1. Small pieces of copper scraped from the pasteurizer or other utensils during the manufacturing process.
2. Long action of sour cream on copper utensils.
3. The presence of small particles of copper in the package of butter or in the wrappings.
4. A certain type of mold.

Remedy: If copper coils, copper pasteurizers, or copper lined vats are used in any part of the buttermaking process, these should be inspected regularly to see that the copper is not scraped by any part of the machinery, and further that in cleaning the copper coils or the linings of the pasteurizer with any kind of a brush or other material, that this does not remove some of the copper by friction. After copper utensils are cleaned they should be carefully flushed with water, to remove any small filings or small particles of copper that may have been left on the surface, and every effort should be made to prevent particles of copper from getting into the cream in any way during the entire process of manufacture.

"Lacking" Flavor in Butter

"Lacking" flavor in butter may be caused by:

1. Churning too sweet cream.
2. Washing the granular butter too much.
3. Churning too rich cream.
4. Failing to use a sour starter.

Remedy: Since it has been shown that certain changes take place in cream if it is held cold and sweet and does not

sour, it is safe to conclude that the butter made from such old, sweet cream will have considerably more flavor than butter made from cream freshly separated, even though it has the same acidity as the older cream.

The "ageing" of cream developes flavors in butter from changes in the casein of the cream, even though the milk sugar is not changed into lactic acid as is the case when cream sours.

Butter churned at a low temperature, say 50° F., and then washed with very cold wash water several times, may have its flavor undeveloped or lacking. In such cases a sour starter or ripening the cream a longer time before churning will develop flavor. Further, washing the granular butter only once to remove the excess of buttermilk will also help to retain the flavor in butter.

Gritty Butter

Gritty butter may be caused by:

1. Very coarse salt.
2. Insufficient working.
3. The size and shape of the salt crystals.
4. Salt not all dissolved because of the large crystals.
5. Too much salt.

Remedy: A buttermaker should take into consideration the size and shape of the crystals of the salt he is using, because fine salt will be easily dissolved in the water of the butter, and easily distributed through it. With such salt the butter needs much less working than with salt having large crystals of peculiar shapes, that do not dissolve quickly.

While working the butter a portion of it should be examined for grittiness and the working continued until this disappears. It is comparatively easy to dissolve all the salt in the butter if the working process is divided into intervals and the butter allowed to stand for fifteen minutes or more between these intervals of working. A complete solution of the salt is much more likely to be obtained in this way than

will be the case if the working is done all at one time without any intervals of rest.

Salt that will pass through a sieve having about thirty meshes to the inch ought to give satisfactory results in so far as the degree of fineness of the salt is concerned. By working the butter deliberately, that is, not trying to hurry the process, a great deal of salt may be saved.

The old rule of one ounce of salt to one pound of butter still holds good. This is adding about 6% of salt to butter, and the amount retained in the butter will depend entirely upon the skillfulness and the good judgment of the butter-maker.

Light salted butter does not contain more than 1 per cent salt, and if the remaining 5 per cent, when salted at the rate of an ounce to the pound, is washed away, this is an unnecessary waste of salt which may easily be avoided by using less salt, by taking more time in the butter-working process, and by giving the butter several workings with a period of rest between each one until the butter is no longer gritty but still has the desired salty taste.

When butter contains 3 per cent salt, which is a little above the average salt content of butter, it does not necessarily have an over-salted taste, but even then one-half the salt added to the butter may have been lost during the working process, provided the butter was originally salted at the rate of one ounce of salt to each one pound of butter.

A great saving in salt may be obtained by the butter-maker using good judgment and not trying to hurry the butter-working.

High Color in Butter

High color in butter may be caused by:

1. Adding too much butter color.
2. Feeding the cows too much green pasture grass at the beginning of the season.

Remedy: The remedy can be easily understood from what is written about too light colored butter. See p. 46.

High Testing Buttermilk

High testing buttermilk may be caused by:

1. Too thin cream when churned.
2. Too sour cream when pasteurized.
3. Holding cream too short a time at a cold temperature before churning it.
4. Too much cream in the churn, especially in farm churning.
5. Both cream and churn too warm when churning starts.

Remedy: The churn should be thoroughly chilled with cold water before adding cream to it and the cream held at a temperature near 52° F. for at least two hours and more if possible, before it is added to the churn.

Before thin, sour cream is pasteurized, it may be neutralized to between .1 per cent and .2 per cent acidity. If this is *not* done, the heating of the cream during the pasteurizing process will enclose some of the fat in the coagulated casein and this may remain in the buttermilk.

When such buttermilk is placed in a tall can and allowed to stand quietly for a few hours, the casein, being heavier than the fat, settles to the bottom of the can.

By testing the top and bottom layer of buttermilk which has stood in a tall can for a few hours, quite a difference in the per cent of fat in the top and bottom buttermilk has been found. The buttermilk at the top of the can contains considerable less butterfat than the buttermilk at the bottom of the can. This shows that pasteurizing the thin, sour cream without neutralizing it has a tendency to enclose a certain amount of fat in the coagulated casein which holds down or anchors the fat so that it drops to the bottom of the can because the casein is heavier than the fat.

Such a demonstration shows that the richer the cream churned the less casein there is to retard the butter from churning and this reduces the losses in the buttermilk, and further, that the more nearly neutral the cream is at the time of pasteurizing, the less the loss of fat in the buttermilk.

Leaky Butter

Leaky butter may be caused by:

1. Insufficient working of the butter.
2. Working too much butter in the churn at one time.
3. Adding water to the butter in the churn to increase the moisture content of the butter.
4. Excessive amount of salt in the butter.
5. Washing the butter with extremely cold water.

Remedy: It has long been known that water will stick to soft fat more tenaciously than to cold fat and as a rule when a buttermaker wishes to increase the moisture content of his butter he either adds water a little warmer than the buttermilk and works this into the butter, or uses a little warmer wash-water. Anything that has a tendency to warm the fat will increase the moisture content of the butter and increase the tendency of the butter to become leaky.

The amount of salt in the butter tends to make the brine leak out of it as this draws the moisture from the butter. Highly salted butter is more likely to be leaky than light salted butter.

The appearance of an excessive amount of brine or moisture on the surface of butter is not always an indication of high moisture in the butter. A dry-looking butter often contains more moisture than a moist appearing butter. As a rule the drier the butter appears to be the more moisture it contains.

Taking everything into consideration, therefore, the way to avoid leaky butter is to give it an excessive amount of working in the churn and keep the salt content down to a reasonable figure. The long working will have a tendency to distribute the brine through the butter in such a way that it will not leak out, and when the butter hardens, the texture will be satisfactory, provided, of course, the working is not over-done.

Light Color in Butter

Light color in butter may be caused by:

1. Failure to add enough butter color to the cream.

2. Exposure of butter to the sunlight.
3. Certain kinds of feed, such as straw, coarse hay, potatoes, and too much dry feed in the winter or any other season of the year.
4. Holding the granular butter in the wash water too long a time before salting and working it.

Remedy: It is claimed that clover hay and silage in a cow's rations have a tendency to deepen the yellow color of the butter and of the milk. But, a ration made up of coarse hay, bran, corn meal, and certain other grains, especially cotton seed meal, have a tendency to give butter a light color.

The amount of artificial butter color added to cream for churning will vary during the season of the year from one to three ounces of color to every one hundred pounds of butter fat in the cream. When cows are on full pasture grass, butter ordinarily needs no artificial coloring.

Different brands of butter color vary in strength, and some of them are so weak that during the winter or dry feed season it is necessary to use three ounces of butter color per hundred pounds butter fat in the cream, in order to get the same effect that is obtained by using one ounce of some other brand of butter color.

The amount of butter color added should be regulated by the natural color of the fat in the cream.

Buttermakers generally know that the butter color, when needed, should be added to the cream before it is churned. If, however, the buttermaker forgets to add the butter color to the cream, it is possible to color the butter by adding color to the butter salt, then adding this colored salt to the granular butter. This colored salt can be uniformly distributed through the butter and it will color the butter in about the same way as would be the case if the color had been added to the cream.

Stripper cows, or cows late in their milking period, usually produce a butter fat of a very light color. This may be remedied by adding the milk and cream of fresh cows to that of stripper cows and churning the mixture.

The action of light on butter color is very noticeable as sunlight will bleach the yellow color from butter when it is

exposed to the air for a sufficient length of time. A thin, white layer on the surface of butter may be noticed, but the interior of the butter will still retain the yellow color.

Limey or Neutralizer Flavor in Butter

Limey or neutralizer flavor in butter may be caused by:

1. Adding too much neutralizer to the cream.
2. Errors in calculating the amount of neutralizer needed for each lot of cream.
3. Adding the neutralizer to the cream too rapidly, so that it is not all immediately dissolved in the cream.
4. Failure to stir the cream during the time the neutralizer is being added.

Remedy: When the excess of acidity in sour cream is neutralized, it is necessary to know the per cent of acid in the cream and the number of pounds of cream. This, together with the knowledge of the strength of the neutralizer, gives the necessary information for determining how much neutralizer must be added to this particular lot of cream.

If for any reason the information just mentioned is not obtained, but neutralizer is added by taste, such a practice is likely to make it easy to get an excessive amount of lime or neutralizer in the cream because the neutralizer does not dissolve in the acid of the cream rapidly, and as soon as an excess of neutralizer is added, this gives an alkaline reaction to the cream and a limey or neutralizer taste to the butter.

In case, for any reason, an excessive amount of neutralizer has been added to a lot of cream, the difficulty can be overcome and the limey or neutralizer flavor in the butter avoided by adding more milk or sour cream to this same lot of cream so as to increase its acidity sufficiently to dissolve all the lime which may have been left undissolved.

Cream is now neutralized to about .2 per cent acidity, and this should be the test of the cream after it has been thoroughly stirred and all the neutralizer completely dissolved, leaving none of the lumps of lime in the bottom of the vat.

The cream will take up this lime gradually, but it may require considerable stirring before it is completely dissolved.

Long Churnings of Butter

Long churnings of butter are caused by:

1. Too cold cream.
2. Too thin cream.
3. Filling the churn too full.
4. Churning in an extremely cold room so that the cream cools off during the churning process.
5. Cream from the milk of stripper cows.

Remedy: Long churnings do not, as a rule, cause the factory buttermaker much trouble, but when butter is made on the farm it often happens that the cream will swell up in the churn without breaking into butter and the churning process may be continued for even a half day or more without churning the cream to butter.

Long churnings are usually noticed during the Fall and Winter when most of the cows producing the milk are late in their milking period, and in addition to this, the cream is allowed to accumulate for several days before a churning of butter is made, and further, this cream is kept in a cold room where, in many cases, it is near the freezing temperature when put into the churn. All three of these conditions are more or less common on the farms where butter is made and are the causes of long churnings.

Thin cream will take a long time to churn unless a small quantity is churned at one time, that is, fill the churn about one-fourth full and then warm up the cream to a temperature of at least 62° at the time of churning.

When cream has been churned for a long time and the butter does not come, add a little water to the churn. This will reduce the viscosity of the cream somewhat, and if this does not help the cream to "break" then add a handful of dry salt to the cream in the churn.

The ideal condition of cream for farm churning is to skim cream testing about 30 per cent fat, fill the churn a little less

than one-half full, warm the cream to a temperature of about 58° F, and do the churning in a room where the temperature will not get much colder than this figure while churning.

If possible, cream from the milk of fresh cows should be mixed with that of stripper cows, as the mixture will churn quicker than cream from milk of stripper cows only.

Losses in Weight of Butter by Evaporation

Losses in weight of one pound bricks or prints of butter may be caused by:

1. Insufficient wrapping of the butter after it is printed into bricks.
2. Keeping the butter in a cold, dry room.
3. Making butter that contains a great deal of loose brine.

Remedy: When the one-pound prints of butter are each weighed on a scale at the time of making, these weighed prints should be immediately wrapped with a parchment wrapper which will hold all the moisture in the butter and prevent evaporation.

These prints of butter are then placed in a paraffined pasteboard carton, and the two wrappings will prevent evaporation and loss in weight, even in a dry room.

Loose Moisture in Butter

Loose moisture in butter may be caused by:

1. Churning the cream at too warm a temperature.
2. Churning too rich cream.
3. Using too warm wash water.
4. Insufficient working.

Remedy: Any treatment of the cream or of the butter that tends to warm it will hold the moisture in such a way that drops of either water or brine will be found in pockets in the butter or in the package in which the butter is placed. A smooth, even, solid looking butter may be made by chilling the butter granules with cold water as soon as the buttermilk

is drawn off, using ice to cool this water, if necessary, and holding the granular butter in cold water a sufficient length of time to harden it.

The moisture or brine can be easily washed out of such hard butter, leaving none of it in a loose condition through the butter or in the butter package.

It is also helpful sometimes to fasten the covers of the churn so they may be slightly open during the time the butter is worked, thus allowing some of the water to run out during the working process as the churn revolves.

The loose moisture can also be avoided by giving the butter about one-third more than the usual amount of working. It will be noticed that the longer the butter is worked, the more the moisture fails to show on the surface of the butter.

Mealy Butter

Mealy butter may be caused by:

1. Melting frozen cream too rapidly.
2. Pasteurizing cream at too high a temperature for too long a time.
3. Coagulating the curd in the sour cream by high heating and failing to take out this curd when washing the butter.
4. Melting into oil the small particles of granular butter which may float in drops on the surface of the cream. When these drops harden and are mixed with the granular butter, they have a tendency to make the butter mealy.
5. Certain cow feeds, such as beet tops, when fed in excess, may cause butter to be mealy.

Remedy: The curd in sour cream is easily separated by heat and the longer the heating, the harder and drier the curd becomes. This may be prevented by reducing the acidity of the cream, then heating it to a low pasteurizing temperature, about 140° F. with the least agitation possible while heating.

Skim off any melted drops of butter oil that may be noticed on the surface of the hot cream.

Avoid any violent agitation of the sour cream, as this will separate small particles of both curd and butter.

Thaw out frozen cream by heating slowly at a low temperature, say about 90° F.

Metallic Flavor in Butter

Metallic flavor in butter may be caused by:

1. Rusty cream cans, cream vats, or rusty tinware used in any part of the butter manufacturing process.
2. Wearing off of the tin and exposing the iron underneath to the action of sour cream.
3. Defective method of pasteurizing the cream, especially when the flash pasteurization method is used.
4. Holding the sour cream in patron's cans, or in defective vats too long a time before churning it.
5. Diluting the rich cream with water.
6. Churning excessively sour cream.

Remedy: Use tinware only which has a smooth coating of tin over the entire surface and never use rusty cans for transporting either milk or cream. If copper containers are used, these must be carefully cleaned to prevent any green substance from developing on the surface of the copper. If cream is received from farmers in rusty cans, both the cream and the can should be returned to the farmer. The creamery utensils, such as forwarmers, pasteurizers, coolers, vats, etc., should be well cleaned and scoured perfectly bright before cream is added to them.

An effort should be made to pasteurize the cream without exposing it to too much air, and to work the butter as little as possible, because air mixed with the butter is one of the things that helps to develop metallic flavor. Cream should not be held too long a time in the vat before churning, and should be neutralized if it is excessively sour.

If the cream is churned sweet, no metallic flavor will develop in the butter. If the cream is neutralized, it should be reduced to at least .2 per cent acidity.

Milky Brine in Butter

Milky brine in butter may be caused by:

1. Churning the cream at too high a temperature.
2. Over-churning until butter collects into lumps.
3. Insufficient washing of the granular butter before adding the salt.
4. Under-working the butter.

Remedy: If cream is churned so that the butter breaks into granules at a temperature around 50° to 52° F., and the buttermilk is then drawn off before it has time to warm up, the last buttermilk draining from the churn will be very much like water. This shows that the butterfat has been almost entirely churned out of the cream.

Churn the butter until the granules are about the size of wheat kernels; larger granules may include some of the buttermilk which is difficult to remove.

Fill the churn about one-half full of wash water having a temperature near 50° F. and revolve the churn three times in order to rinse off the buttermilk from the granules. Draw off this water, and the remaining granular butter will have very little, if any, milky brine left in it.

The Moisture Content of Butter

The moisture content of butter is influenced by:

1. The amount of cream in the churn.
2. The rapidity of churning.
3. The temperature of the cream churned.
4. The size of the butter granules.
5. The amount of draining given the granular butter before salting.
6. The temperature of the wash water.
7. The amount of washing given the butter.
8. The accurate thermometer.

Remedy for Too High Moisture: If a test is made of the finished butter before taking it from the churn, and this shows too much moisture, the butter should be given another period of working with the drain plugs of the churn open. If, after this working, the moisture is no lower than the first test showed, the butter should be left in the churn and considerable cold water added to it, leaving the butter in this cold water until its surface at least is hardened, then draw off the water and work the butter further. Moisture can usually be squeezed out of hard butter by repeated working.

In case the moisture in the butter is still too high, it should be taken from the churn, placed in packages and left in a refrigerator or on ice until the butter becomes very hard. This may require a period of several hours, possibly over night. After the butter has become thoroughly hardened, it may be broken up with ladles, put back into the churn in small pieces, and these covered with ice water and allowed to stand until the butter is firm and solid. At this point the ice water can be drawn off and the butter worked again with the drain plugs of the churn open. This will usually remove surplus water from the butter because water does not stick to cold butter nearly so tenaciously as it does to warm or soft butter.

If the treatment just described does not remove all the moisture desired, a small quantity of dry salt may be added to the pieces of hard butter in the churn and this salt worked through the butter. A certain amount of the moisture in butter will be taken up by the dry salt to make brine, and this brine may be worked out of the butter without increasing the salt content very much.

Remedy for Low Moisture: Butter too low in moisture is usually obtained during the winter season when cream is churned cold and the hard butter granules are washed with cold water.

Low moisture content of butter, under certain conditions, may be prevented by adding to the hard, granular butter, wash water having a temperature of five to eight degrees warmer than the buttermilk. This will soften the surface of the butter so that more moisture will stick to it. Further, the moisture content of a churning of butter may be increased by

adding a weighed amount of water to the butter in the churn and then working this into the butter in the following way.

Suppose the test of the finished butter ready to take from the churn shows it contains 12 per cent moisture, and the buttermaker wishes to raise it to 15 per cent.

In order to do this it is necessary to know the approximate amount of butter in the churn, which may be 500 pounds. If now we wish to add 3 per cent moisture; a calculation will show that 3 per cent of 500 pounds is 15 pounds. This 15 pounds of water is then added to the butter in the churn and by a few revolutions through the working rolls of the churn this loose water will be taken up by the butter. It is always safe, however, to make another moisture test of the butter before removing it from the churn.

In a general way the factors influencing the moisture content of butter may be summarized as follows:

The more cream there is in the churn the more likely will the butter contain a low moisture content, as a rapid churning gives a high moisture butter and when the churn is too full the cream churns slowly.

The warmer the cream churned the higher the moisture content of the butter.

The larger the butter granules, the more moisture they will hold.

The drier the butter granules are drained, the less moisture the butter will contain.

The warmer the wash water, the higher the moisture content of the butter and the colder the wash water the lower the moisture content of the butter.

The more working the butter is given with the drain plugs of the churn open, the more moisture will be worked out of the butter.

An accurate thermometer is more helpful for taking cream and butter temperatures than a thermometer which may be five to ten degrees above or below standard.

Moldy Butter

Moldy butter may be caused by:

1. Damp refrigerators, damp freight cars, damp butter cellars or storage rooms.

2. Dusty store rooms for butter packages, such as tubs and parchment liners.
3. Rinsing the tub or packages with stagnant or cloudy water.
4. Churning raw cream.
4. Moderately warm storage rooms.
6. Sour or unclean cans, vats, pipes and churns.
7. Musty or dusty butter salt.

Remedy: It is comparatively easy to prevent moldy butter, moldy parchment linings, or moldy packages if one remembers that mold spores are microscopic plants which grow easily when they are supplied with food, air and moisture, and that these mold seeds are present everywhere in the dust that may accumulate on the surface of anything.

Since it is necessary for these mold spores to have a certain amount of moisture to make them grow, all that is needed to prevent their growth is to keep the butter packages and the butter in a dry, clean place.

Many chemicals, with mysterious sounding names, such as formaldehyde, chloride of lime, boric acid, and other substances have been suggested for killing mold spores; but it is entirely unnecessary to use these because mold spores are destroyed by a temperature of 130° Fahrenheit.

Hot water treatment will kill all the mold spores, providing the heat comes in contact with every part of the package or the liner.

When butter is packed and sold or stored in 60-pound tubs, the empty tubs should be kept in a clean, dry room and just before using them placed in a tank of hot water which holds enough water to cover the entire tub. This not only tightens the staves but helps to remove any woody flavor from the surface of the tub; it also kills the mold spore.

Each tub should be carefully cleaned before soaking it in hot water and all moldy, dirty spots inside or outside removed with a scrubbing brush and clean water. The parchment liners for the tubs should be placed in hot water or in hot brine for the purpose of killing the mold spores which may be lodged on the surface, and care should be taken to sepa-

rate each liner so that the hot water or hot brine will come in contact with the entire surface of the parchment paper.

After this kind of care is taken of the package and liner, the filled tubs must be held in a dry refrigerator, shipped to the buyer in a dry refrigerator car and held until sold in a dry, cold room.

Some of the formaldehyde treatments which have been suggested, such as 5 parts formaldehyde to 95 parts of water, have a decidedly irritating effect on the skin of the workman's hands in handling either the packages or the parchment liners in this solution; and even one part of formaldehyde in 300 parts of water will act on the skin, making the use of formaldehyde decidedly objectionable.

Remembering now that mold will grow in the presence of air, moisture, and dust, all one needs to do is to provide conditions that will either destroy mold or prevent its growth. This may be done with the hot water treatment already described, by providing conditions that prevent the growth of mold, including good ventilation and dry air in the rooms where the butter tubs and other supplies are stored, by covering the inside of the tubs with hot paraffine and when necessary by spraying the walls of the storage room or refrigerator with a weak solution of formaline.

The milk pails, cream cans, creamery vats, pipes and faucets must be continually cleaned and scalded and the cream always pasteurized before churning.

Mottles in Butter

Mottles in butter may be caused by:

1. Uneven distribution of salt through the butter.
2. Variation in the size and in the distribution of the water droplets through the butter mass.
3. Insufficient working of the butter.
4. Failure to divide the butter working process into intervals with a period of rest between each one.
5. Uneven working of different parts of the same churning of butter.

6. Failure to uniformly distribute the salt over the butter when it is added to the granular butter.

7. Defects in the butter working rolls of the machine in which the butter is worked.

8. Overloading the butter-working rolls so that some of the butter goes over instead of passing through them.

9. Excessively cold wash water which chills the outside surface of the granules without hardening the softened fat in the center of the granules.

Remedy: Many general statements about mottles in butter have been made in years past. These vary from suggestions about the temperature of working the butter to the length of time butter is held in storage. No exact knowledge of the facts in regard to mottled butter were well formulated until it was found by examining a thin slice of butter under the microscope that the water or brine is distributed through it in microscopic droplets that vary greatly in size and in number. It was further noted that this distribution of water droplets changed the color of the butter by influencing the way in which the rays of light are reflected from the surface of butter.

The color is not the same when light is reflected from a butter surface containing a comparatively few, large droplets of water as it is when light is reflected from a butter surface having many smaller water droplets.

A lighter shade of yellow, approaching nearly white is found in those parts of the butter where the water droplets are largest and most numerous, while the deeper shades of yellow are noted in those parts of the butter where the moisture droplets are extremely fine and uniformly distributed.

If butter is worked without salting, the water droplets are found to be uniform in size and evenly distributed throughout the entire mass of the butter. As soon, however, as salt is added to the butter, it collects these fine drops of moisture into larger ones by osmotic action, drawing out the water from the butter where it is held in suspension.

Unsalted butter is seldom mottled and salted butter can be made of a uniform color without mottles if sufficient time

is given for the salt to dissolve in the water and this brine is then mixed uniformly through every portion of the butter.

It is, of course, true that a small amount of curd in the butter may have a tendency to take up moisture more readily than the fat of the butter and this uneven distribution of the curd has a slight effect on the distribution of the water droplets through the butter.

Mottled butter may, therefore, be easily prevented by:

1. Distributing the salt uniformly over the granular butter in the churn and giving the butter about one-third the amount of working which the operator thinks it needs. This may be called the first working.
2. Allow the butter to stand for fifteen minutes or more so that the salt may absorb moisture from the butter and become dissolved into brine.
3. Give the butter another short working for the purpose of evenly distributing the brine through the mass of the butter.
4. Allow the butter to stand for a second interval of fifteen minutes, after which give it this third portion of working which should be about as long as the first. The third working ought to insure a complete distribution of the brine through the butter, not only making the water droplets uniform in size, but uniformly distributing them through the butter.

If the buttermaker will keep in mind the cause of mottles, all he needs to do is to regulate the butter-working process so that the salt is given an opportunity to become thoroughly dissolved in the water; then the brine must be distributed evenly through the mass of the butter and every pound of it must receive the same amount of working.

Salted butter has a deeper shade of yellow color than unsalted and the variation in the shades of yellow are caused by the lack of uniformity in the distribution of the minute water drops or brine drops through the mass of the butter.

Musty Butter

Musty butter may be caused by:

1. Storing the butter packages in a poorly ventilated or a damp room.
2. Allowing the milk or cream to stand in a poorly ventilated place.
3. Failing to scald the pails, cans and butter packages immediately before using them.
4. Shipping the butter to market in musty refrigerator cars.
5. A damp refrigerator at the creamery where the butter is stored before shipping.

Remedy: It sometimes happens that butter is shipped to market in musty refrigerator cars, or it is held at the creamery and possibly in the buyer's wholesale house in a musty room. This must be avoided, as butter, milk, and cream absorb odors from the atmosphere easily and rapidly.

Musty butter tubs or butter tub linings may be treated with hot water and salt to remove this contamination, but the safest way is to keep all butter packages, liners, covers, etc., in a well ventilated room so that they do not accumulate the musty flavor.

If cans of milk or of cream as well as a shipment of butter are covered with a horse blanket or some musty canvas covering while drawn to the factory or to market, the milk, cream, or butter may absorb a musty flavor from this kind of a cover, as will also be the case if the milk or the cream cans are held at the farm in a musty room before delivery to the factory.

Navy Butter

General Requirements for 1925:

The butter shall be made from fresh, pasteurized cream (held at a temperature of 145° F. for 25 minutes, or at 176° F. for an instant), none of the cream shall contain or shall have contained more than 0.234 per cent of acid calculated as lactic acid (nor more acid in 50 c.c. of cream than will be

neutralized by 13 c.c. of tenth-normal alkali solution), nor shall the cream contain more than 35 per cent butterfat.

The moisture in the butter at the time of packing shall not exceed 13.5 per cent, and the butter shall be salted at the rate of not less than 2.5 per cent or more than 3.25 per cent salt in the finished product at the time of packing the butter, and no preservative other than common salt shall be added to the butter.

The Government inspectors shall make all necessary tests to determine that the acid in the milk or cream and the salt and moisture content of the butter are within the limits specified.

It is possible for the contractor to make his own tests of the milk, cream and butter, but the final inspection shall be made by the Government agent after delivery.

The Government submits the following specifications about the packing of butter in tubs. The butter must be put up in regular, sound, first-quality, white ash tubs, provided with sound covers and five sound wooden hoops, two at the bottom, one at the center, and two near the top, or three metal hoops. Tubs shall hold from 60 to 65 pounds net weight each of butter.

The tubs and covers must be soaked in the usual manner, properly steamed and immediately thereafter coated on the inside with paraffine applied at a temperature not less than 240° F. They must then be lined with parchment paper (side linings, bottom and top circles), which must first have been sterilized and then soaked in a clean brine solution for at least thirty minutes immediately preceding the time at which they are used.

The parchment lining must overlap the bottom and the top edges of the butter at least half an inch. The product must be packed immediately after it is made, each tub must be packed solid and completely filled. A cloth circle must be placed on the top of the parchment circle of each tub and covered with a thin layer of salt. Tub covers must be securely fastened by two strips of substantial flat iron not less than one-half inch in width, securely fastened to the sides of the tub and brought over at right angles.

By means of a suitable rubber stamp and stamp ink, each tub shall be plainly marked on the cover and side with the

net weight of the butter it contains, the name of the contractor, with or without brand, the number of the contract and the date of packing, and shall be free from all other marks except such as may be placed thereon by the Government inspector.

The letters in the rubber stamp must be not less than three-eighths inch high and three-sixteenths inches wide. Markings by means of a stencil or blacking will not be permitted.

Butter packed in all states except California, Oregon and Washington will be made during the period of 90 days after May 15th and before Aug. 31st.

As soon as packed and until placed in cold storage, all the butter must be kept at a temperature below 50° F.

Neutralizing Excess of Acidity in Cream

The following is a brief description of a method for neutralizing the excessive acidity that develops in cream when it sours either by holding it too long on the farm, or by letting it stand in a creamery, or by taking a long trip on a railroad baggage car, especially in warm weather.

The neutralizing of this surplus sourness has been found to reduce the losses of butter in the buttermilk when cream is churned, and it also helps to improve the keeping quality of the butter.

A number of good alkalies have been suggested for use in neutralizing excessively sour cream. These can be bought from manufacturers.

If one wishes to neutralize cream with home-made neutralizer, it is possible to make a liquid that will answer this purpose by using the ordinary lump lime found where building material is for sale.

In order to prepare the neutralizer from lump lime it is necessary first to select clean pieces of white, lump lime that contains the least possible amount of sand and clay. Place these in a can, then add about one-third a can-ful of hot water. The water soon begins to boil as the lime is added to it, and only enough water should be used to form a rather thin, creamy liquid having the milk-of-lime in suspension. The more this creamy milk-of-lime is stirred, the better, as this insures all the small pieces of lime becoming slacked.

When the milky liquid has cooled, it is strained through thin cloth to take out the lumps, and the milky liquid which passes through the strainer is used for neutralizing the sour cream.

In order to find out just how much of the milky lime liquid each lot of cream needs, the first thing to do is to make an acid test of the cream in the cream vat. After this, add about one pint of the milky lime liquid to the cream in the vat and thoroughly stir this until the lime is all dissolved in the sour cream.

At this point make a second acid test of the cream. Then, by comparing the first acid test with the second, the difference will show how much the acidity in this vat of cream has been reduced by one pint of the milky lime liquid. Calculate then how many more pints it is necessary to add to this vat of cream in order to reduce the acidity to the required figure.

Such a calculation may be illustrated by supposing the first acid test of the cream shows it to contain .65 per cent acidity, and the second test, after adding the pint of milky lime liquid and stirring it thoroughly showed a test of .55 per cent acidity. These figures indicate that one pint of the milky liquid will neutralize .1 per cent acidity, and since it is only desired to reduce the acidity to about .2 per cent and we have found that one pint will reduce it from .65 per cent to .55 per cent acidity, then we will need to add three pints more of the liquid to reduce it from .55 per cent to .25 per cent acidity.

The sour cream will take up the alkali more slowly at the end of the addition of the milky lime than at the beginning, and it may be advisable to allow the cream to be stirred for a time after adding all the neutralizer, in order to be sure that it is all dissolved in the sour cream and none of it left as a powder on the bottom of the vat.

Such testing and calculating of the amount of milk-of-lime needed for each lot of cream, although it is very simple, must always be done for each vat of cream neutralized.

If the neutralizer is made in the proportion of 85 lbs. of water to 15 lbs. of quicklime, then the amount of this neutralizer necessary to use in sour cream may be found by multiplying the pounds of lactic acid which need to be neutralized by two, and the figure thus obtained will be the amount of

lime mixture that should be used. The amount of lactic acid in the sour cream is obtained by titration. If 1,000 lbs. of cream has an acidity of .5 per cent, and we want to neutralize it down to .2 per cent acid, then we have .3 per cent lactic acid to be neutralized or in 1,000 lbs. of cream we have 3. lbs. lactic acid and this multiplied by two gives 6 lbs. of the milk-of lime mixture (15 lb. to 85 lbs. water) which will reduce the acidity in the 1,000 lbs. of cream to .2 per cent acidity.

The milk of lime should always be added to the cream before pasteurizing, as this process usually reduces the acidity about .1 per cent. This, however, varies in different localities and during different seasons of the year; also with the amount of acidity in each lot of cream to which the neutralizer is to be added.

In no case should the sour cream be reduced lower than .2 per cent acidity.

Care should always be taken to add enough milk-of-lime or any other neutralizer to partially reduce the acidity, but never to completely neutralize it and leave the cream alkaline, as an excessive amount of neutralizer will spoil the flavor of the butter and also its texture.

Another important point to notice in mixing the milk-of-lime with the cream is to take plenty of time for this mixing, as the lactic acid of the cream may dissolve the lime rather slowly and every precaution possible should be taken to prevent having an excess of neutralizer.

In slaking the lump lime with water, it has been found that about 15 lbs. of lime to 85 lbs. of water will make a good mixture.

Answers to Questions on Neutralizing Cream for Buttermaking

1. What substances are used for neutralizing sour cream?
   Lime, soda compounds, magnesia, and almost any other harmless alkali.

2. What do you mean by harmless alkali?
   Those containing the same minerals as are found in the ash of normal milk, and used in small quantities.

Remedy: Carefully inspect the butter color used; notice its odor and the amount of sediment in the can or bottle. Do not use more color than your trade needs.

Inspect the butter cartons, if these are used; there should be no loose oil or oily spots on the paper.

Do not ripen the cream above a temperature of 65° F. after it has been pasteurized. The richness of the cream should not be more than 35 per cent fat, better around 30 per cent. Do not thin the cream with water. If no skim milk or thin cream is available for diluting the excessively rich cream, use skim milk powder dissolved in water. Reduce the acidity to .2 per cent or a trifle less before pasteurizing. Run the pasteurizer at a moderate speed.

Do not pasteurize the excessively sour cream at a high temperature.

Steam the cream delivery cans instead of rinsing them with water only.

Require the patrons to cool their cream and keep it in a clean place until delivery. Churn and work the butter at a low temperature, near 52° F.

"Old Cream" Flavor in Butter

"Old Cream" flavor in butter may be caused by:

1. Sour milk pails, or milk cans and sour cream separators.
2. Failing to cool the cream immediately after separating it.
3. Mixing the warm cream from the separator with the cold cream of a previous separation.
4. Letting the cream sour too much at the farm before delivering it to the buyer.
5. Dirty utensils at the creamery.
6. Failing to lime the churn or to sweeten it in some way before churning.

Remedy: Farm separators should be carefully cleaned each time after using them for skimming milk. If any milky water is left in the separator bowl after washing it, this will

sour and fill the bowl with an "old cream" odor that will be transmitted to the sweet cream of the next skimming. This will be carried along to the butter made from such cream.

The same effect on the butter is caused by using milk pails or milk cans that are not thoroughly cleaned and steamed, and by keeping the cream until it gets sour at the farm, or when the cream is drawn to the factory long distances without a canvas or some other covering that protects the cans from hot weather in summer.

If the creamery receives excessively sour cream, this should be neutralized to about .2 per cent acid before churning it.

Adding some sweet skim milk or a small quantity of clean, whole milk to the cream before churning will help somewhat to overcome this old cream flavor in the butter.

Creameries that do not receive cream enough to churn even so often as every other day in the Winter, may hold their cream too long before churning it. It is better to churn the small quantities of cream at least four times per week rather than try to do all the churning at the factory twice per week, even in cold weather.

After the butter is made it must not be held in the factory refrigerator more than a few days unless the temperature of the refrigerator is 40° F., or lower.

Pasteurizing Cream for Buttermaking

Pasteurizing milk and cream, as the term is used in the manufacture of dairy products, means the heating of these products to a temperature that will kill approximately 99 per cent of the bacteria in the milk or cream.

Sweet cream is easily heated to any reasonable temperature up to 185° F. without any great change taking place in it, except destroying the bacteria, but when sour cream is heated, it is necessary to first neutralize the excessive acidity as described on page 62. This will prevent the coagulation of the curd around the fat globules in the cream and such neutralized cream will churn cleaner, leaving less fat in the buttermilk than will be the case if the sour cream is heated to a pasteurizing temperature without neutralizing it.

A number of different methods of heating the cream have been suggested and are now practiced at creameries where pasteurized butter is made.

One of the methods of pasteurizing a neutralized sour cream is to run it through a continuous pasteurizer, where it is heated to a temperature of about 180° F. The cream, as it leaves the pasteurizer, is then run over a coil cooler which reduces the temperature to at least 70° F. It is then run into a cream ripening vat where a starter is added. The length of time the cream is allowed to stand after mixing with the starter varies, but eventually the cream is cooled to near 50° F. and held at this temperature from two to twelve hours before churning it.

Another method of pasteurizing neutralized, sour cream is to first heat it in a forewarmer to a temperature of about 120° F., then run it through a continuous pasteurizer where it is heated to a temperature of 170° F.; it is then passed over a coil cooler and from this into a holding vat where the cream stands at a temperature near 50° F. from two to twelve hours before it is churned.

A third method of pasteurizing cream is to run it directly into a holding vat, in which it is mixed and heated to a temperature of about 145° F. for twenty minutes, then cooled down to 70°; the starter added and after standing a few hours the cream is cooled to near 50° F. and held at this temperature from two to twelve hours before it is churned.

The choice of any one of these methods of pasteurizing cream depends largely on the equipment the creamery has on hand and the economy with which the equipment can be operated.

The two essential points in making a good quality of butter from pasteurized cream are:

1. The cream should be sweet or neutralized to .2 per cent acidity or less before pasteurizing it.
2. After the heating process the cream must be cooled to a low temperature, near 50° F. and held at this temperature long enough to completely solidify the butterfat in the hot cream. This cooling hardens the butterfat and helps to give a firm, solid texture to the butter and also reduces the losses in the buttermilk.

The cost of pasteurizing either milk or cream may be estimated by determining:

1. The cost of fuel, which is ordinarily reduced to the cost of producing one pound of steam.
2. The cost of cooling the milk or cream after heating.
3. The cost of labor.
4. The cost of equipment.

In calculating the cost of fuel for pasteurizing, it is customary to find the heat units in one pound of steam, the standard of which is usually the heat required to raise the temperature of one pound of water one degree Fahrenheit. This information may be obtained in several ways, 1. By allowing pressure steam to collect in a weighed amount of water until the temperature of the water rises between two observed figures; then weigh the water a second time and note the increase in weight caused by the steam which has been condensed by the water. 2. Collect the water from the condensed steam that comes from the heating arrangement of the pasteurizer and weigh the water so obtained.

An estimate of the cost of cooling the milk or cream after heating must take into consideration the loss by evaporation of steam from the hot milk and cream, and this loss is influenced more or less by the kind of cooler used.

As a rule the tubular coolers are most efficient, not only because the milk or cream is spread over a thin layer on the surface of the cooler, but because these coolers afford an opportunity for considerable evaporation of the hot liquid as it passes over the surface of the tubular cooler.

The most rapid cooling takes place when there is a great difference between the temperature of the hot liquid and the cold water or brine used for cooling. Consequently a large stream of water flowing through the cooler will cool the hot liquid quicker than a slow stream, and further, the temperature of the cooling water will naturally influence the cost as well as the rapidity of cooling.

The labor cost of pasteurizing is influenced considerably by the kind of pasteurizer used. Some of these require more time of a workman than others require. The vat or holder

type of pasteurizer takes less of the operator's time than the continuous pasteurizer, and when the latter is used, especially for pasteurizing cream for buttermaking, the cream ripener can be used as a pasteurizer and no additional machinery need be bought as the pasteurizing and the cream ripening may be done in one vat.

A few observations indicate that the labor cost of pasteurizing is about three times as great with a flash pasteurizer as with the vat pasteurizer.

The regenerative pasteurizer which permits the milk or cream to pass through the machine in a continuous stream reduces the fuel cost nearly one-half according to observations reported by Bowen in bulletin No. 85, U. S. Dept. of Agriculture, 1914. In the regenerative pasteurizer the hot and cold milk or cream, exchange temperatures with the hot and cold water of the machine, and in this way the heating and cooling is economically done.

The difference in the cost of pasteurizing cream for buttermaking by the vat or held process, as compared with the flash method of pasteurizing the cream has been calculated by Mortenson per pound of butterfat in the cream.

The total cost of pasteurizing by the continuous or flash method of heating was 0.164c and by the vat or held method of heating, 0.078c.

Bowen gives the cost of pasteurizing one pound of butterfat in cream by the continuous process as .209c and by the held process .091c, and he further states that vat pasteurization uses about 17 per cent less heat than flash pasteurization.

The details of Bowen's table on cost of pasteurizing milk per pound of butterfat follow:

	Continuous Method	*Vat Method*
Cost of Steam	.019c	.016c
Cost of Water	.009c	.021c
Cost of Labor and equipment	.181c	.054c
Total	.209c	.091c

He further estimates the cost of pasteurizing one gallon of milk at 0.313c, one gallon of cream at 0.634c.

Rancid Flavor in Butter

Rancid flavor in butter may be caused by:

1. Changes in the chemical composition of the butterfat from a neutral to a butyric acid compound.
2. Exposure of butter to the air at a warm temperature.
3. Too much curd in the butter.
4. Any condition which may have a tendency to change butter into butyric acid.

Remedy: A butyric acid flavor may develop in cream as well as in butter; therefore no cream having an excessive acidity should be churned, if one is planning to make butter of extra quality.

A thorough washing of the granular butter in clean, cold water will help to remove any traces of butyric acid which may have developed in the cream. The butterfat of butter changes somewhat when kept for a long time even at a cold temperature, unless this temperature is zero or lower.

The natural change of butter fat into butyric acid which gives a rancid flavor will gradually take place if the butter is kept at too warm a temperature and exposed to the air as the air helps to oxidize a part of the butter into butyric acid.

A high curd content of the butter also aids in supplying food for the bacteria which, when present in the butter, have a tendency to make it rancid.

Salvey Butter

Salvey butter may be caused by:

1. Churning a warm, thin cream.
2. Over-churning the butter.
3. Over-working the butter.

Remedy: Thin cream, testing around 20 per cent fat often requires a long time for churning, especially if the cream has a temperature near 50° F. Such long churning is often

responsible for the salvey body in butter. The time required to churn such thin cream may be reduced by warming it to a temperature of about 58°, and not adding too much cream to the churn.

If the cream is very rich, it can be churned at a temperature near 50° within a reasonable length of time, but thin cream must be churned at a higher temperature because the proportion of fat to the serum in the cream is smaller than in a rich cream, and such thin cream necessarily takes a longer time for the butter to separate from the serum, or "break", as the expression is used by buttermakers. The longer the churning of the cream before it breaks, the more likely the salvey condition of the butter. (See also explanation under "Greasy body of butter.")

Sandy Body in Butter

Sandy body in butter may be caused by:

1. The kind of agitation given the cream during the heating or cooling process.
2. The amount of cream in the ripening vat.
3. The temperature to which the cream is heated.
4. Certain kinds of feed the cows are eating.

Remedy: If the cream is pasteurized, the stirring of the cream during the heating process must not be excessive because particles or granules of butter may be churned out by the agitation and pasteurizing heat will melt these granules to fine drops of butter oil.

This condition is caused not only by the excessive speed of the stirring arrangement, but by the fact that the vat in which the cream is heated may not be filled above the revolving shaft of the heating coils, which causes greater agitation than is the case if the stirring coil in the vat is completely covered with cream.

In case it is necessary to heat a small quantity of cream in a large vat, the speed of the stirring coils may be reduced so that it will not agitate the cream to such an extent as to slightly churn the cream during the heating and the cooling processes.

Some cow feeds, like beet tops, are said to have an influence on the sandy body of butter if these are fed in too large a quantity; they seem to contain some constituents that change the composition of the fat and make it somewhat difficult to get the butter particles to stick together into one mass.

Salt Testing of Butter

In order to find out how much salt a sample of butter contains, it is necessary to have the following equipment:

1. A scale for weighing 10 grams of butter.
2. A 250 c.c. flask.
3. A number of Mason jars or bottles holding a pint, at least.
4. A 17.6 c.c. pipette.
5. A white procelain cup.
6. A standard solution of potassium chromate.
7. An indicator.
8. A standard solution of silver nitrate.

Weigh ten grams of a carefully mixed sample of butter into a piece of white parchment paper, then force this, paper and all, through the neck of your 250 c.c. flask and add hot water to the butter in the flask until the butter is all dissolved.

The flask is then filled up to the mark, 250 c.c., with warm water and after being mixed thoroughly, a part of it may be poured into a Mason jar, throwing the rest of the contents of the 250 c.c. flask away.

By providing a number of Mason jars, several samples of butter may be tested with the same 250 c.c. flask. The only point necessary to observe is to weigh out exactly 10 grams of butter, then dissolve the salt out of the butter by adding the 250 c.c. of warm water. A part of this may be saved in a Mason jar, and the salt test made later.

After the samples have been prepared in this way, the liquid in each Mason jar is tested as follows:

Fill a 17.6 c.c. pipette with this liquid from the Mason jar, empty this into a white porcelain cup or a glass dish, then add a few frops of the potassium chromate liquid, a yellowish indicator, and measure from your burette containing the standard nitrate of silver solution a sufficient quantity to change the color of the liquid to a faint orange color.

This process is usually called a titration. It is like the process used in testing the acidity of milk or cream, and by reading the number of c.c. of silver nitrate solution needed for giving this color to the 17.6 c.c. of the sample of butter tested, we may calculate the per cent of salt in that sample. One c.c. of the solution represents one per cent of salt.

The silver nitrate solution is made by dissolving 5.1 grams of silver nitrate in 250 c.c. of water, and one c.c. of this solution represents 1 per cent of salt when 10 grams of butter are tested.

If we found by titrating a sample of butter that it required 3.5 c.c. of silver nitrate to color 17.6 c.c. of the liquid found by dissolving the 10 grams of butter in warm water, this shows that the butter contains 3.5 per cent salt.

In making the silver nitrate solution, suppose we buy 3 grams of silver nitrate. This three grams is now added to a 250 c.c. flask, and you want to know how much distilled water must be added to this 3 grams nitrate of silver in order to make the strength equal to 5.1 grams of 250 c.c. This may be found approximately as follows:

If you wish to have 5.1 grams nitrate of silver in 250 c.c. of water, this is the same as .0204 grams of silver nitrate in one c.c. of water, and since you have 3 grams nitrate of silver in the flask, you will need to add as much water to it as 3 divided by .0204, which is 145 c.c. water.

Scorched Flavor in Butter

Scorched flavor in butter may be caused by:

1. Holding the cream too long a time at a high temperature during the pasteurizing process.
2. Over-heating the coils in the forwarmer of the pasteurizing equipment.
3. Heating the sweet cream for too long a time above a temperature of 145° F.

4. Fluctuation of the amount of cream going through the flash pasteurizer from small quantities to larger amounts.

5. Allowing the casein to burn on the hot surface of the flash pasteurizer because of the excessively hot temperature of the heating walls of the pasteurizer or the sudden reduction in the amount of the cream passing through it.

Remedy: It is very important in pasteurizing cream to have the continuous pasteurizer equipment so arranged that the flow of cream is uniform and does not fluctuate from small amounts to large quantities during the pasteurizing process. It is also a good plan to occasionally inspect the thermometer used in the pasteurizing process as these may sometimes be from 5 to 10 degrees too high or too low, and the pasteurizing temperatures are not accurately recorded. Further, it is helpful to run some cream through the pasteurizer before turning on the steam so that the first small quantity does not become scorched on the walls of the heater.

Careful inspection of the heating surface of the cream pasteurizer, after completing the work each day will show whether or not the cream has burnt on to the metal surface of the heater. If this is the case, the proper precautions should be taken to prevent it in the future.

Short Churnings of Butter

Short churnings of butter are caused by:

1. Rich cream.
2. Warm temperature.
3. Small amount of cream in the churn.

Remedy: When the butter comes after churning only a short time, it is likely to be soft; it will also contain considerable buttermilk and the buttermilk will be rich. If sweet cream is churned when warm and the butter comes in fifteen minutes or less, it is sometimes profitable to run the buttermilk through a separator and skim it as the buttermilk may

be rich enough to make this operation pay for the labor of skimming.

Churning cream at a temperature above 62° F. causes a short churning and a rich buttermilk. But if the same cream is cooled to a temperature of about 50° F., this cream will require a longer time for churning, the butter will come in smaller granules, the buttermilk is easily washed out of it with cold water, and the butter will be of better quality than that made from the cream churned at a warmer temperature.

If a thin cream is churned at a warm temperature, that is, above 62° F., the losses of the butter in the buttermilk will be even greater than from a rich cream because a larger quantity of buttermilk will be obtained from the thin cream than from a rich cream.

The ideal temperature for churning is about 50° F. for a cream that tests about 30 per cent fat, and in addition to these two points, the churn should be cooled off with cold water and the churning done in a rather cold room so that the temperature of the cream does not rise very much during the churning process.

Cream that churns in a short time, say fifteen minutes, is likely to make a weak bodied butter, and conditions should be provided that will require a longer time of churning, such as cooling the cream and holding it cold several hours before the churning, also increasing the richness of the cream and washing the butter in ice water.

Short Grain in Butter

Short grain in butter may be caused by:

1. Too many stripper cows producing the milk.
2. Change from pasture to dry feed.
3. Frozen cream.

Remedy: When the cows of nearly all the patrons of the creamery are nearly dry, as is sometimes the case in the fall or winter season, the butter made from cream of these cows could be very much improved if the milk of such cows is skimmed so as to get a very rich cream, and then to this rich cream a certain amount of milk from fresh cows is added.

It is much better to have the herds of the patrons so arranged that there will be some fresh cows during the entire year because the fat in the milk of stripper cows is harder and the fat globules are smaller than is the case when these same cows are fresh milkers. Both these conditions have an effect on the texture of the butter, and when stripper cows are in the majority, the butter is likely to be short grained.

If a creamery is so situated that farmers are obliged to give their cows a large amount of dry feed, because of lack of silage or from some seasonable condition, this excessive dry feeding will have an effect on the composition of the butter and a larger percentage of the hard fat will be found in the milk. Such a condition can be easily overcome by feeding silage, root crops, or some green feed.

When a large amount of cream comes to a factory frozen in the cans and this is simply melted and churned within a reasonable time after receiving it, the body and texture of the butter may be injured.

A good remedy for this condition is to thaw out the cream slowly by placing the cans in a tank of water having a temperature of about 100° F. This will melt the ice, but the cream will not get too warm.

If such cream, after thawing out, is churned in the usual way, the texture and body of the butter will be much better than if the frozen cream is rapidly thawed out and churned soon after it is received.

Silage Flavor in Milk, Cream or Butter

Silage flavor in milk, cream or butter may be caused by:

1. Leaving waste silage in the cow's manger or using it for bedding.
2. Poorly ventilated cow stables.
3. Leaving open the silo door into the cow stable.
4. Feeding the cows silage before, rather than after milking.

Remedy: The old prejudice against feeding silage to cows because it taints the milk is now changed into an urgent recommendation for all dairy farmers to provide as much silage as possible for their cows both summer and winter.

Feeding silage may increase the amount of milk the cows give, but it does not increase the richness of the milk.

The secret of feeding silage successfully to dairy cows is to keep the air of the cow stable free from silage odor because it has been demonstrated that if milk has a silage flavor this has been absorbed after milking. It does not go through the cows' digestive system into the milk, but through the air of the stable into the milk as it stands in pails, cans, and other utensils after milking.

Milk may be protected from the silage odor by cleaning and removing from the stable the waste silage from the cow's manger; by providing the cow stable with good ventilation and by keeping the silo door closed except during the period when silage is taken out for feeding purposes.

The draft of air should be from the stable, up through the top of the silo and not from the silo down into the cow stable.

The last and most important point, is to feed the silage after, rather than before or during milking.

Some of the highest priced milk sold at the present time is produced from cows fed silage, but the simple precautions mentioned are taken to prevent the milk absorbing the silage odor after it is drawn from the cows.

Sour Flavor in Butter

Sour flavor in butter and other dairy products may be caused by:

1. Sour milk cans or sour wash cloths used at the farm.
2. Too thin cream which has developed an excess of acidity.
3. Over-ripe starter.
4. Cream too sour when churned.
5. Failing to wash out all the buttermilk from the granular butter.

Remedy: All dairy utensils should be cleaned with a brush instead of a cloth; and in factory, washing the milk and cream cans, use plenty of steam to dry the cans. Fill the

cans full of clean, cold water on the farm and let them stand full for a few hours.

Skim a rich cream testing about 30 per cent fat, or more, to remove an excess of skim milk, as this sours easily and excessively. The cream should not be allowed to sour above 0.5 per cent acid, and the starter should not have much more acid than this when added to the cream (never so high as .7 per cent acid.)

Do not mix excessively sour cream with sweet cream, because the butter will have the flavor of the sour cream. Churn the two lots of cream separately. Stop churning when the butter granules are small and thoroughly wash out the buttermilk.

Churn the cream as cold as possible. When washing the granular butter, let it stand a few minutes in cold water before drawing off the water, and avoid churning to too large granules as it is hard to remove sour buttermilk enclosed in them.

Stable Flavors in Butter

Stable flavors in butter and other dairy products may be caused by:

1. Lack of ventilation, or lack of clean air in the cow stable.
2. Failure to clean the cows and the milker before each milking.
3. Keeping the milk in the stable after milking.
4. Setting up and using the cream separator in the cow stable.
5. Covering the cans of milk or cream with a horse blanket, either to prevent freezing at night or during transportation to the buyer of the cream.

Remedy: It is a comparatively easy matter to keep the cow stable warm and at the same time well ventilated during cold weather. It is fully as important to ventilate the cow stable as it is to ventilate a school room, and by giving the matter some attention an arrangement can be made

that will permit a current of clean, pure air to pass through the cow stable without making it too cold.

There is a law in some states forbidding the use of a cream separator in the cow stable. It must be placed in a special building or in a room of an adjoining building, to protect the milk, cream and butter from stable flavors.

It is also important that the persons who milk the cows should clean the cows' udders and flanks and wash and dry the hands before milking the cows.

The milk or cream cooling tank should be entirely separate from the cow stable, and removed a sufficient distance from manure piles. The clean milk pails and milk cans ought to be kept in a room where the air is fresh and clean with no possibility of stable contamination.

Stale Flavor in Butter

Stale flavor in butter may be caused by:

1. Keeping the butter too long a time at a temperature around 50° F.
2. Old and stale farm cream.
3. Holding the cream too long in the creamery vat, as is sometimes the case in small factories during the winter season when churnings are made only twice a week.
4. Cream from cows near the end of their lactation period (stripper cows).
5. Shipping butter in a freight car that is not well ventilated, especially when butter is a long time on the road.
6. Failing to soak the butter tubs enough before using them.

Remedy: If the cream comes from milk of stripper cows it should be mixed with twice as much cream from the milk of nearly fresh cows.

Both the factory man and the farmer should carefully inspect the shipping cans to see if they are in first class condition.

A good, active starter added to cream inclined to be stale will sometimes produce butter of a good quality, provided the cream is well pasteurized and cooled to about 70° F. before the starter is added.

Every refrigerator and store room where the butter is held after making, or the tubs are kept before filling, must be dry and well ventilated and when butter tubs are bought, they should be examined to note if they are comparatively freshly made, and have no objectionable odor. The same thing is true of butter cartons; these should be examined before they are used for shipping butter to market.

Sticky Butter

Sticky butter may be caused by:

1. Churning the cream too soon after pasteurizing it.
2. Failing to cool the cream for a long enough time before churning it.
3. The condition of the wood of the churn.
4. Over-working the butter.

Remedy: Cream should be allowed to stand in the vat at a temperature near 50° F. for at least two hours before churning. This applies not only to cream that has been pasteurized and cooled, but also to cream as it comes from the separator.

The heating of milk for separating and of cream for pasteurizing sometimes melts the butterfat, especially when these are violently agitated during the heating and this may give butter an undesirable texture, but if, after pasteurizing, the cream is cooled for a sufficient number of hours to harden the fat the cream will churn normally.

The condition of the wood of the churn will influence the stickiness of the butter to some extent, but this can be easily overcome by first rinsing the churn with very hot water, then drawing this off and adding very cold water, to cool the wood after heating it.

This sudden changing of the wood from hot to cold seems to bring the fiber of the wood into such a condition that butter does not stick to it.

The amount of working butter gets is often the cause of sticky butter, principally when the working is overdone.

It is an easy matter to prevent this condition of the butter by reducing the amount of working or by dividing the working process into intervals as described under "Mottled Butter."

Butter Sticking to the Churn

Butter sticking to the churn may be caused by:

1. Failure to scald the churn.
2. Failure to cool the churn immediately after scalding it.
3. Old, water-soaked wood.

Remedy: Either a new churn or one to which the butter sticks more or less, may be treated in the following way:

First, fill the churn completely full with water so that it overflows when the covers are at the top. Let this water stand in the churn at least over night, drawing off the water next morning and adding about one-third a churnful of scalding hot water, then revolve the churn with this hot water in it, leaving the vent open so that the steam may escape while the churn is revolving.

Second, draw off the hot water and add the coldest water available, filling the churn at least one-half with this cold water. Let this cold water stand in the churn until the wood is thoroughly chilled; if necessary, add a little ice to the water.

The sudden changing from hot to cold has an effect on the wood of the churn that prevents butter from sticking to it.

It is always a good plan, after using a churn and thoroughly scalding it, to sprinkle clean lime over the inside of the churn, powdering the entire inside surface. Then leave this lime on the wood until the next churning.

The lime left in the churn over night may be easily removed by rinsing it with hot water and then with cold water the next morning. If this does not take out all the lime, a can full of buttermilk may be added to the churn and revolved a few times before adding the cream.

Storage Flavor in Butter

Storage flavor in butter may be caused by:

1. Churning the cream at too high a temperature.
2. Holding the butter too long a time at a warm temperature.
3. Excessively sour cream.
4. Keeping the butter too long a time in cold storage.

Remedy: If butter must be held in storage for any great length of time, it should be kept in a room having a temperature below zero. It is also advisable to sell storage butter to the consumer as soon as possible after removing it from the warehouse, as this peculiar storage flavor develops rapidly when it is kept in an ordinary refrigerator after standing some weeks or months at a temperature below zero.

Grading the cream will also help to prevent storage flavor, and if sour cream is churned, it may be neutralized at about .2 per cent acidity before adding the starter and churning.

Swelling of Cream in the Churn

Swelling of cream in the churn may be caused by:

1. Cream too cold during churning process.
2. The viscosity of the cream.
3. The thinness of the cream.

Remedy: The amount of expansion or swelling of the cream varies somewhat with different churnings, but it usually reaches its maximum before the cream "breaks" in the churn. The fullness of the churn also has some influence on the extent to which the swelling of the cream retards the churning process. If a churn is not over one-third full of cream, having a temperature not lower than 55° F., there will not be much danger of the cream swelling sufficiently to fill the churn, especially if the cream has at least 25 per cent fat.

The effect the viscosity has on the swelling of the cream in the churn is usually noticed at such factories where the

cows are nearly dry or during the latter part of their milking period. Such milk and cream has a much more viscous serum than milk and cream from fresh cows or cows earlier in their milking period.

If the cream is likely to swell in the churn so that it will not fall as the churn revolves, a handful of salt thrown into the churn will often correct the viscosity of the serum and the churning may be completed without too much swelling of the cream.

Sweet Cream Butter

The important points to be observed in making sweet cream butter are:

1. Skim a cream as rich as 30 per cent fat. If it is 35 per cent, so much the better.
2. Cool the cream to a temperature near 50° F. or lower and hold at this cool temperature for 12 to 24 hours.
3. Cool the churn in which this cream is to be placed. This can probably be most conveniently done by filling the churn with cold water to which a lump of ice has been added, or by placing the churn filled with cold water in a cold room for a few hours.
4. Churn the rich, sweet cream in the churn thoroughly cooled, but be sure and do not fill the churn more than one-third full of cream for each churning. The churning should be done in a room where the temperature does not rise above 60° F.
5. Such cream as described will require a long time to churn, but you will find when the butter comes that it will have a firm texture, the buttermilk will be thin, and the flavor of the butter that of sweet cream. The thickness of the buttermilk will depend almost entirely on the temperature of the room in which the churning is done. If it is warm, the buttermilk will be rich, but if kept down to 55° F., the buttermilk will be thin.
6. When the butter comes, draw off the buttermilk and wash the butter three times with cold water. This

amount of washing ought to remove all the buttermilk and this is necessary for making a butter which will keep well under all conditions. After thoroughly washing the butter, salt it lightly and work until the salt is thoroughly distributed through the butter.

7. Use a small amount of salt.
8. Work the butter just enough to mix the salt with it thoroughly.
9. Keep the butter in a cold place until it reaches the consumer.
10. Carefully steam and cool the packages into which the butter is packed.

Tallowy Flavor in Butter

Tallowy flavor in butter may be caused by:

1. Cream kept too warm at the farm.
2. Excessively sour cream.
3. Too high pasteurizing temperature.
4. Too much aeration when heating sour cream.
5. Rusty cans or vats.
6. Too much neutralizer.

Remedy: Inspect the farmers' cans and all vats or pipes in the factory that come in contact with the sour cream. These should not have rusty or bare iron spots, but ought to be well tinned to prevent excessively sour cream from dissolving the iron in small quantities and thus helping to make the substance that gives a tallowy flavor to both milk, cream, and butter.

Too much air, light, and heat in pasteurizing and in cooling the cream when this is over-sour will aid in developing this defect. Too much air mixed with the butter either by overworking it or by failing to pack it solid in the tubs, will also aid in developing this defect.

Keep the cream sweet and cold and hold the butter in a cold refrigerator.

Unclean Flavor in Butter

Unclean flavor in butter and other dairy products may be caused by:

1. A cream separator that is not scalded with hot water after washing it and just before using it for skimming milk.
2. A sour milk strainer, musty milk pails and milk cans.
3. Colostrum milk.
4. Dirty wash water at farm or factory.
5. Milk or cream pumps, pipes, and faucets which have collected deposits of curd that fermented and contaminate the cream.

Remedy: The use of hot water and steam on all farm milk utensils and creamery vats and pipes will clean up the unclean flavor in butter.

Further, do not use milk or cream from cows until three days after calving and keep the cream from the "stripper" cow's milk, separate from that of fresh cows. Milk the cows with clean dry hands or with a clean machine.

A Variation in the Fat and Water Content of the Butter

A variation in the fat and water content of the butter in one churning may be caused by:

1. The churn is not standing level on the floor.
2. The drain plug of the churn is not close to the wall of the churn.
3. The butter is leaky and not sufficiently worked.
4. The butter sample is not properly taken from the churn or correctly tested after it is taken.

Remedy: Many striking results reported by buttermakers on the variation in the composition of the butter in one churning are caused by lack of care in taking and in testing the sample of butter.

It should be remembered that butter is a mixture of fat and brine and in order to get a small quantity, such as ten grams for testing, it is necessary to use care and good judgment in selecting the pieces of butter from different parts of the churning.

After this sample is taken, it should not be warmed sufficiently to melt but just enough to soften the butter so that it can be properly stirred into a homogenous mixture.

Every buttermaker should get a little practice in testing and sampling two or more samples of butter from one churning. By taking the two samples and carrying them through the fat and moisture tests, making both in as **nearly** the same way as possible, he may be surprised at the difference in the results he obtains, and until he has educated himself sufficiently to make a reasonable comparison in this way he is not sufficiently trained to determine by his own analysis whether the butter at different ends of the churn are of the same composition or not.

By testing the fat and moisture content of seventy-three churnings of butter, we have found that in 90 per cent of these churnings the butter in different parts of one churning did not vary more than .5 of one per cent in butter fat, when the churn stood on a level floor and the wash water or brine which leaks from the butter during the working process drained out of the churn easily and did not collect at one end as would be the case if the drain plug is so located that the brine does not all drain out of the churn.

Unless these points are carefully watched, the butter at the drain end of the churn may contain one per cent less fat than the butter at the gear end of the churn, and the moisture content of the butter will vary a little although all results of this kind are influenced by the care taken in sampling the butter from the churn and in testing the sample after it is taken.

Wavy Butter

Wavy butter may be caused by:

1. Uneven working of different portions of the same churning.
2. Overloading the butter-worker.

3. Some defect or fault in the butter-working rolls that prevents all the butter getting the same amount of working.
4. Uneven distribution of the moisture droplets through the butter.
5. Loose bearings of the working rolls of the churn.

Remedy: It has already been shown under "Mottles in Butter," that a uniform shade of yellow color in butter is influenced by the even distribution of the moisture droplets through the mass of the butter, the same cause is responsible for the uneven or wavy color of butter. This latter defect, however, differs from mottles in being not quite so pronounced or about half way between mottles and no mottles.

When it seems to be impossible to remove the wavy color of butter by repeated workings, an investigation of the butter-workers should be made to find out if the butter working rolls are securely fastened and are also in perfect alignment.

If there is any looseness in the bearings or slipping of one roll over the other, this will prevent all the butter getting the same amount of working, and when this is the case the fine moisture droplets are not uniformly distributed through the entire mass of each churning of butter.

Another thing that should be guarded against is the amount of butter that is worked at one time. If the butter-worker is over-loaded, this will also prevent the uneven distribution of the moisture droplets through the entire mass of the butter.

Each working of butter should include the amount which the size of the butter-worker is designed to take care of by the manufacturer of the machine.

Weak Body in Butter

Weak body in butter may be caused by:

1. Failure to cool the cream and hold it at a cold temperature for any length of time before churning.
2. Churning the cream at too high a temperature.
3. Over-working the butter when it is too soft.

4. Excessive green feed for the cows, or sudden changes from dry stable feed to full pasture grass.

Remedy: When cows are first turned to pasture in the spring, or changed at any time of the year from dry feed to green feed, this should be done gradually, giving the cows at the beginning only about one-quarter of the total feed of grass and gradually increasing the time in pasture until the cow's system becomes accustomed to the change of feed and is able to convert her food into butterfat having a higher melting point than the milk fat she manufactures from green feed.

Considerable weak bodied butter is ordinarily received on the market in June, when cows first go to pasture, and feeding experiments have shown that the porportion of soft fat in the milk fat is larger on grass feed than when the cows are stall-fed during the winter season.

In case milk and cream are received from cows on full pasture early in the spring and the buttermaker wishes to do the best he can with it, he should cool this cream near to 50° F. and hold it for several hours at this temperature. Then churn the cream in a cold churn, and if the butter comes soft, draw off the buttermilk, wash the granular butter with cold water, allowing it to stand in the churn in this cold water a sufficient length of time to harden the butter granules, using ice if necessary for this purpose.

Such butter should be worked very little, and if it is placed in the package in a cold place so that the butter hardens, there will probably be very little complaint from the buyer of a weak body in the butter. The best way, however, to overcome this defect, is to induce the parties owning the cows to change gradually from dry to pasture feed or any other green food and avoid a too sudden change.

Weedy Flavor in Butter

Weedy flavor in butter and other dairy products is caused by:

1. Strong flavored weeds such as wild onions, leaks, garlic, and ragweed, which the cows pick up in the pasture.

2. Feeding turnip tops or roots in excess.

3. Feeding cabbage or pumpkins before or during milking.

4. Exposing the milk or the cream to an atmosphere which contains objectionable food odors such as brewers' grains or slightly decayed feed of any kind.

Remedy: When silage has a strong odor, and other feeds such as turnips, roots, cabbage, etc., are fed to cows during milking, the milk will absorb this odor, and it will be distinctly noticed in the cream and the butter. All such feeds should be given the cows after and not before milking.

It is difficult to remove the flavor of garlic, wild onion, ragweed, and some of the strongly flavored grasses, from milk cream or butter, and if these are found in the pasture the cows should either be changed to another pasture or that portion fenced off so that the cows cannot eat such weeds.

Pasteurization and aeration of the cream will help to remove some of the weedy flavor, but may not be depended on to take out the flavor of wild onion, garlic and ragweed. The cows must be protected from getting these weeds as feed.

The cow stable must be well ventilated and the cows fed good, sound clean pasture grass and other feeds. It is perfectly safe to feed clean, sound, corn silage, if the silo and the stable are well ventilated and the waste silage removed from the manger and stalls before it contaminates the air of the stable at milking time.

Neither the milk nor the cream should be allowed to stand in the feed room, but should be removed to a milk house or clean water tank. Blowing air through the milk or cream, when these are warm, will help to remove some of the weedy flavors, but not all of them.

Weeds in the pasture may be eradicated by late Fall plowing and harrowing in the Spring, or Summer. Spraying the weeds about the middle of April has been suggested, but it is not widely practiced.

All feeds having objectionable odors should be fed to cows after milking, but never before or during milking.

White Butter

White butter may be caused by:

1. Exposure of the butter to sunlight or daylight.
2. The breed of the cows.
3. The feed of the cows.

If a piece of butter is exposed to the daylight for even a day or two the surface of the butter will turn white. This is because light destroys the yellow color or fades it. This white coating does not necessarily change the food value of the butter; it is simply a surface layer, and by scraping it off the butter will be found to be of its natural yellow color and of the same composition as the white butter.

This kind of white butter is entirely different than the various shades of light and deep yellow color found sometimes in butter and due to the feed of the cows or to the individual peculiarity of the cows. Some have a natural breed color like the Guernsey butter, and with others it is a characteristic trait in the animal to produce a light or a deep yellow colored butter.

It is claimed that feeds like clover hay, pasture grass, green silage and some others have a tendency to give butter a deep yellow color, while such feeds as potatoes, beets, straw, cottonseed meal, and some others have a tendency to give it a whitish shade of yellow color.

The breed characteristic of butter color varies even with the different animals of one breed. As a rule the Guernsey butter has a deeper yellow color, than that of most other breeds.

White Crystals on the Surface of Butter

White crystals on the surface of butter may be caused by:

1. Keeping the butter in a dry place.

The appearance of white salt particles on the surface of butter is usually noticed more in the Winter season than in Summer. This is especially true in cold localities where the air is dry. Nearly all butter is more or less covered on the surface with small drops of water or brine, and when this

butter is placed in a dry refrigerator or a cold room, the moisture evaporates from these drops of brine and leaves the salt behind as white crystals.

This appearance of dry salt crystals on the surface of butter may be prevented by keeping the butter in a damp place, or by providing some arrangement which will cause a certain amount of water evaporation in the room so that the air will not take the moisture out of the butter. This can sometimes be done by placing a shallow pan of water on the floor, or by having a dish of water near the butter so that the evaporation of the water will fill the air with water vapor and prevent the evaporation of the water from the brine on the surface of the butter.

White Specks in Butter

White specks in butter may be caused by:

1. Small particles of curd.
2. Failure to wash the granular butter in the churn thoroughly.
3. Over-ripe starter.
4. Over-ripe cream.
5. Lack of stirring during the cream ripening process.
6. Failure to strain the cream into the churn.

Remedy: The cream which may dry on the can cover or around the edges of the surface of the cream in the ripening vat should not be added to the cream in the churn, but should be churned separately. These pieces of dry cream remain in the butter as white specks of curd if they are not removed by the strainer or by a thorough washing of the granular butter at the end of the churning.

The starter should be in a good soft condition when added to the cream because if it is over-ripe the curd begins to toughen and these hard particles of curd remain in the butter when the butter washing is hurriedly done.

If one has cream or starter with white specks of curd which do not soften up during the churning process, it is a good plan

to fill the churn half full of water after draining off the buttermilk, then let the granular butter float on the surface of this water and the curd sink to the bottom where this may be drawn off through the draining plug of the churn. By repeating this washing of the granular butter several times it is often possible to remove the white specks before the granular butter is salted and worked into a finished product.

Winter Flavor in Butter

Winter flavor in butter may be caused by:

1. Frozen cream and a poorly ventilated room in which the cream is kept at the farm before it is delivered to the buttermaker.

Remedy: The term, "Winter Flavor" is rather an indefinite one when applied to butter, but it usually means that the cream has been kept on the farm several days in a cold place or in a place where it is sufficiently cold to prevent the cream from souring. Under such conditions, cream develops a flavor which judges have given this name of "wintry."

This defect, like many others, can be overcome by delivering the milk and cream to the buyer at least every other day, even in the Winter and by cooling the milk and cream immediately after milking and separating and removing it from the cow stable.

At some very small creameries where churnings are made only twice a week, the cream gets so old that this Winter flavor develops at the creamery and it may easily be overcome by churning at least every other day.

Woody Flavor in Butter

Woody flavor in butter may be caused by:

1. New churns which have not been washed with lime water and then thoroughly scalded before they are used.
2. Decayed or partly decayed wood in the churn.
3. Butter salt taken from barrels which have not been properly dried, or the wood has partly decayed.

4. Wooden butter packages.

5. Failure to scrub and to scald the butter tubs or the butter package.

6. Wooden milk pails or wooden receptacles for cream on the farm.

7. Using unsuitable lumber for making butter boxes, tubs and other packages in which the butter is shipped to market.

Remedy: A new churn should be carefully inspected to see if every inch of the wood is perfectly sound; that no knots or partly decayed or dozy spots of wood can be found in any part of the churn.

It is a good plan to fill the new churn at least one-third full of water; then put a little lime in it and, after revolving the churn with this lime water several times, allow it to stand over night in the churn. Another good way is to put a few pails of milk of lime in the churn, revolve it sufficiently to paint this over the inside of the churn. Then allow the churn to stand over night. Next morning this lime water can be rinsed out with cold water and the churn scrubbed with a brush where needed.

After this treatment the churn may be filled with buttermilk or sour milk, and this allowed to stand in the churn a few hours before finally cleaning with scalding hot water and then cooling with cold water. It is then ready to receive the cream. If the woody flavor persists in the churn or the odor is not exactly what is wanted, more buttermilk should be added to it and this allowed to stand over night or longer, if necessary.

When butter is sold in tubs, these should be made of well seasoned wood, parafined and then lined with parchment paper. The wood used in boxes for shipping print butter should always be carefully selected, refusing a wood which has a peculiar odor or flavor that can not be removed by parafining the inside of the boxes. The use of wooden milk pails and other wooden utensils for milking or holding cream at the farm is both unsanitary and objectionable.

Working Butter

Working butter is a process designed for:

1. Evenly distributing the salt through the butter.
2. Removing the buttermilk from the butter granules.
3. Preventing a milky brine.
4. Giving the butter a uniform body or texture.

There are a number of ways of working butter, and if unsalted butter is made, about all the working such butter needs is enough to bring it together into a butter mass that has a springy texture and not a salvey one. Over-worked butter, when it is pulled apart, has the objectionable texture that is something like stringy gum.

When salted butter is worked, the principal object, after working out the buttermilk, is to get the salt evenly distributed through the butter, and this may be done by first working the butter about one-third the amount it needs. This will dissolve the salt with the exception of some of the larger salt crystals. The butter is then allowed to stand for fifteen minutes or longer to complete the dissolving of the salt in the moisture of the butter.

At the end of this time a second working, of about one-third the total amount, is given the butter, and it is allowed to stand another period of fifteen minutes or more. This second working will help to dissolve the last traces of salt and also to distribute the brine evenly through the butter by expelling the original moisture or permitting the salt to take this up as brine.

The third, or last working will help to distribute the moisture, brine and salt through the butter and it should then have a uniform color and texture.

A perfect texture of butter is compared to a fracture of broken steel, with no tendency to a stringy, gummy body.

Yeasty Flavor in Butter

Yeasty flavor in butter may be caused by:

1. Yeast fermentation in either the milk or the cream.

2. Holding such cream at a high temperature before it is delivered to the buyer.
3. Failure to steam and sterilize all the pipes, pails, cans, vats, etc., either at the farm or at the creamery where the butter is made.
4. Lack of care at the cream station and holding the cream too long before it is churned.

Remedy: The best way to avoid yeasty flavor in the butter is to refuse cream having a yeasty flavor. If it is accepted, such cream should be churned by itself and the butter sold on its merits.

The milking utensils and the cream separator must be scalded each time they are used in order to destroy the yeasty flavor. Cool the cream to near 50° F., and keep it cool at the farm and also during transportation to the buyer. Frequent delivery of the cream will also help to remove this defect.

Yeasts and Mold in Butter

Yeasts and Molds in butter may be caused by:

1. Failure to rinse the milk cans, the strainer cloth and all utensils used on the farm, with hot water after washing them.
2. Returning whey, skimmilk, or buttermilk to the farm in the same cans used for taking milk or cream to the factory.
3. Failing to scald the inside of the churn at the creamery with boiling water.
4. Churning raw cream, that is, cream that has not been pasteurized.
5. Using butter packages that have not been thoroughly scalded before packing butter in them.

Remedy; Yeasts and molds in butter may easily be destroyed long before the butter comes in the churn. If the cream is pasteurized by heating it up to 145° F. for twenty minutes or by heating it in what is called a "flash" pasteur-

izer or a continuous heater to a temperature of 185° F., this will destroy the yeasts and molds that may get into the milk or cream before it reached the churn.

An examination of butter for yeasts and molds is a good test of the way in which the cream has been pasteurized before churning. If the yeasts and molds in one gram of butter are found to be as many as 50 to 100, and in some cases 1000 or more, this is good evidence that the pasteurizing process as it is used at the factory has not been efficient.

When cream has actually been pasteurized according to the usual directions for pasteurizing cream, the churn has been thoroughly scalded and the handling of the butter from the churn to the butter packages is done in a clean way, the yeasts and molds in one gram of butter ought not to exceed 10 to 30.

Yellow Specks in Butter

Yellow specks in butter may be caused by:

1. A sediment in the butter color.
2. Allowing the butter to stand in a warm place for a short time so that the surface softens more than the interior of the butter in the package.
3. Use of too much color.
4. Uneven working of the butter.

Remedy: When adding butter color to cream, the clearness of the color oil should be carefully noticed and if there is any sediment in the container, the butter color should be discarded or allowed to stand until all the particles settle to the bottom of the bottle in which the butter color is bought.

Butter color should be kept in the refrigerator until used.

If butter is shipped to market or held at the factory, it should be stored in a place having a uniform temperature and not left so that one side of the package is heated by being near a radiator or stove. The surface of the butter in this way is warmed and in some cases melted, thus changing the butter so that the oil may separate and when this hardens it has a different color than before.

CHAPTER II

Butter Testing

The testing of each churning of butter made in our creameries is an important matter for at least two reasons: first, for giving the buttermaker accurate knowledge about the yield of butter he is obtaining, and second, for showing whether or not the butter is of legal composition.

The importance of the first item may be readily understood by remembering the fact that legal butter must contain at least 80 per cent fat, therefore, if the buttermaker's practice is such that he is making butter containing 85 per cent fat, then the yield at his creamery is 5 per cent less than it might be if he tested each churning of butter and changed his methods of making, so as to manufacture butter containing about 80, instead of 85 per cent fat. This loss of 5 per cent in the factory yield of butter falls on the patrons, and they receive just that much less money for their milk or cream delivered to such a creamery.

It is true that not many creameries at the present time are making butter containing 85 per cent fat, but undoubtedly a great deal of butter is made that contains at least 83 per cent fat, and if so small an amount as 500,000 lbs. of butter per year is made at a creamery, and it is losing 3 per cent of this because the butter contains 83 per cent instead of 80 per cent fat, this 3 per cent of 500,000 is 15,000 lbs. of butter, which, at 40c a pound, is $6,000 per year. This may seem like a large figure, but it can be easily shown that a buttermaker could earn from one to six thousand dollars per year for a creamery making 500,000 lbs. of butter, if the patrons would provide a suitable place and the necessary equipment at the creamery for testing butter and then insist on the buttermaker making these tests of each churning just as regularly as he carries on the other parts of the everyday work of a buttermaker.

The importance of the second item, making legal butter, is apparent to everyone interested in the manufacture of this product because if the butter contains less than 80 per cent fat it is classed as adulterated butter and the creamery is liable to have to pay a heavy fine for making illegal or adulterated butter.

These two important items in the manufacture of butter have convinced nearly all creamery operators, managers, and buttermakers that a training in butter testing and the necessary apparatus for making such tests are fully as important as the churning, working, or any other part of the buttermaker's work as it is carried on in the creamery.

Many creamery buttermakers as well as some creamery patrons are well aware of the importance of the butter testing part of the everyday work, but this has been more or less neglected because it adds one more duty to the daily routine of a buttermaker, and no one has insisted on his performing it. Many buttermakers and patrons seem to be willing to take chances on being caught by the Internal Revenue officers and being heavily fined for making adulterated butter. And no one of the patrons seems to be sufficiently interested to investigate the creamery operations and to find out whether or not the maximum yield of butter is obtained in each churning.

The per cent of fat in each churning of butter is not considered to be of any serious consequence, first, because the buttermaker gets his wages regardless of the composition of the butter, and second, because the patrons take little interest in the yield of the butter at the creamery, assuming this to be the buttermaker's business and therefore they do not insist on the daily tests and records being made that will show whether or not the maximum yield of butter is obtained in each churning at their creamery.

Methods of Testing Butter

There are four methods now more or less used in creameries for testing the butter of each churning:

1. The moisture test.
2. The gasoline test.
3. The Shaw test.
4. The Farrington Butter test.

The Moisture test shows the per cent of water or moisture in the butter; the Gasoline test gives both the moisture and the fat content of the butter; the Shaw test shows the per

cent of fat in the butter; and the Farrington butter test also determines the fat in the butter.

A considerable number of creameries are equipped with the apparatus for making moisture or water tests of butter, but unfortunately this test is not made of each churning of butter at all creameries, the buttermaker assuming that an occasional test is sufficient to determine whether or not he is making legal or illegal butter.

The moisture tests of butter do not give any evidence as to the per cent of salt or curd in the butter, and very little in regard to the per cent of fat, although this may be estimated approximately from the moisture test.

As a rule, where butter is made daily in our creameries by uniform methods of salting and working it, the per cent of salt and curd do not vary very much, so that the buttermaker gets an approximate idea of the per cent of fat in each churning by testing the butter for moisture and assuming that the salt and curd equal about 3 per cent more and this, added to the moisture, gives a figure which subtracted from one hundred, shows approximately the fat content of the butter.

This reasoning from one moisture test of a churning of butter is better than no testing whatever; but it gives very little evidence as to whether or not the buttermaker is getting the maximum yield of butter from the cream he is churning, as it does not show whether the butter contains 80, 82, or 85 per cent fat, although it may show that the butter contains less than 16 per cent moisture.

If a buttermaker wishes to find out whether or not he is getting the maximum yield of butter, he should examine the per cent of fat in each churning by some one of the methods now available for this purpose.

When a buttermaker uses the approved methods of pasteurizing and ripening his cream, as well as of churning, salting and working it, he is fairly safe in assuming that if the butter contains from 15 per cent to 15.5 per cent moisture, it will also contain 80 per cent or more of fat. This is generally a safe deduction, but it has been found that there is some variation in the moisture and fat content of the butter in one churning, and cases have been known in which the result of butter tests made by the buttermaker at the creamery differ

somewhat from those made by the buyer of the butter at the market to which it has been shipped.

Some of the Sources of Errors in Butter Testing

1. Sample not carefully taken.
2. Sample too small.
3. Melting the sample so that the fat separates from the brine or water.
4. Inaccurate butter-testing scales.
5. Careless weighing on the butter-testing scales.
6. Weighing hot dishes.
7. Position in the churn from which the sample is taken.

The amount of butter taken for a sample must depend somewhat on the quantity of butter which the sample is supposed to represent. If a package of butter is to be tested, the sample may be taken by drawing with the ordinary butter trier a core of butter from the entire length of the package and then taking small portions from this butter core, or possibly the entire trier-full.

If the butter lies on the rolls of the churn and a test of it is desired, a sample may be taken with a spatula, table knife, or spoon by dipping portions about the size of the first joint of a man's thumb from at least six different places in the churn, and putting these into a sample bottle.

A convenient butter sample bottle is the one-half pint fruit jar, or a wide-mouthed glass-stoppered bottle.

The **preparation of a sample** after taking it from the churn or the butter package requires careful attention. The most important point is the warming of the sample of butter in the bottle just enough to soften it. It should not be heated sufficiently to melt the butter so that the brine separates from the fat. It may be placed in a dish of water having a temperature of about 110° F., holding the bottle with one hand in this dish of water, and with the other hand stirring the butter in the bottle with a case knife. As soon as the butter has softened enough to be mixed into a thick liquid

with the stirrer, the bottle should be removed from the hot water, but the stirring continued while the butter is cooling.

A sample taken in this way will have the moisture or brine drops uniformly mixed through the fat so that the small quantity taken out for weighing and testing will fairly represent the larger sample.

The **butter testing scales** should be kept in a box protected from dust and from water or steam. The pans of the scales must be clean and the dishes used for testing the butter should be clean and dry also, before they are weighed, but never weighed while hot.

In weighing the butter testing samples, great care must be taken to note that the scales work freely, and that the scale is sensitive to at least one-tenth of a gram.

Since the sampling of butter is much more difficult than the sampling of milk or of sweet cream for testing, the buttermaker in testing his butter must constantly use great care and good judgment in taking the samples from each churning and in preparing the samples for testing.

Because of the difficulty in taking accurate samples of butter, we have made a large number of comparisons to show what variation there is likely to be in the butter and how closely two tests of the same churning ought to agree.

Samples of Butter Taken at Gear, Center and Drain End of Churn

The claim has been made that the composition of butter is not the same in all parts of one churning. Some think that the butter at the drain end of the churn is always higher in moisture and lower in fat than the butter at the gear end of the churn or at the center. The reason given for this claim is the fact that in working the butter with the drain plug of the churn open, the brine or the moisture gradually accumulates at the drain end of the churn during the working process and more of it is retained by the butter at this end of the churn than at the center or gear end of the churn.

This difference in the composition of the butter, taken from different parts of the same churning, has been used as an explanation for finding more than 16 per cent moisture in some of the butter taken out of one churning and condemning it as adulterated, while other tubs from the same churning con-

tained less than 16 per cent moisture, thus convicting or acquitting the buttermaker for making illegal butter, depending on the part of the churning from which the sample of butter was taken.

It has generally been assumed that butter as it lies on the rolls, six feet in length, ready to be taken out of the churn and packed into the selling package, is of the same composition during the entire length of the churn. It may, of course, be argued that the butter at the drain end of the churn, where a certain amount of brine accumulates, should be a little higher in moisture than the butter at the gear end of the churn, but lacking any definite information on this point we made a number of observations in connection with the every-day work of our creamery.

Our observations covered 73 churnings of 600 to 1,000 pounds of butter each, and were made during both summer and winter conditions. They included over 300 tests.

A summary of all the tests shows that there were no differences in the composition of the butter taken from the two ends and middle of the churn in 22, or 30 per cent of the churnings, i. e., the tests of the three samples of butter taken from one churning did not differ more than .2 per cent, e. g., the fat per cent was 81.2 and 81.4.

In 18, or 25 per cent of the churnings, the difference in the composition of the butter taken from the gear, the center and the gate end of the churn was from .3 to .5 per cent.

In 20, or 27 per cent of the churnings, the difference in the test of three samples taken from one churning varied from .5 to 1 per cent, while in the remaining 18 per cent of the churnings the three samples varied from 1 per cent to 1.5 per cent in butterfat.

The tests were all made by men with considerable experience, not only in buttermaking, but in butter testing.

These observations go to show that there is no fixed rule in regard to the uniformity in the composition of butter taken from one churning.

Approximately one-third of our samples taken from different parts of the same churning shows that the butter of one churning was of a uniform composition from one end of the churn to the other, but in two-thirds of the churnings there was a difference in the composition of the butter in one

churning, varying from .2 to nearly 2 per cent in the moisture content.

The uniform composition of butter in a churn depends somewhat on the churn standing on a level, with neither the gear nor the drain end higher than the other, and the drain plug of the churn so placed that no water is held in the churn while this is open.

Because of the fact that butter is a mixture of oil and water so to speak, or more strictly, butterfat and brine, and further that these two substances have a tendency to repel rather than to attract each other, it is not at all surprising that by testing several butter samples the per cent of fat and other constituents varies even in butter taken from different parts of the same churning.

Milk and Cream Starters

The making of a starter for ripening cream in buttermaking or for adding to sweet milk in cheese making is a comparatively simple operation.

Sweet skim milk is heated to a temperature of about 185° F for at least one-half an hour. It is then cooled to about 70° F. and to the cooled skim milk a small quantity of previously soured milk or a so-called pure culture is added. After stirring sufficiently to mix the culture with the skim milk it is allowed to stand at a temperature of from 70° to 100° F. until the skim milk has soured to about .5 per cent acidity.

This is the starter; and the coagulated curd in it should be soft with a clean taste and an agreeable odor.

When a starter is used in buttermaking the greatest benefit from it may be obtained in pasteurized cream, that is, cream that has been heated to a temperature of at least 150° F. for fifteen minutes and then cooled to 70° F. before the starter is added. After thoroughly mixing the starter with the cream it may stand for a few hours at a temperature near 70° F. in order that the bacteria planted in the cream by the starter may have a chance to grow and further control the souring of the cream.

If a high flavored butter is wanted, add about 10 per cent of starter to the cream and hold it at a temperature of 70° F., until it has reached about .6 per cent acidity. If butter of a

mild flavor is desired, the cream should be held until it reaches about .3 per cent acidity. As soon as the cream has reached the acidity desired it should be cooled to as near 40° F. as possible and held at this cold temperature until churning time. The longer the cream is held cold the better the texture and the firmer the body of the butter.

The loss of fat in buttermilk is also reduced by holding the cream at a low temperature before churning. If the cream can be held at near 40° F. for four hours, fairly good results will be obtained, but the body of the butter will be improved by holding the cream at this temperature for a longer time, even over night.

In cheesemaking about 1. per cent of starter, made as described above, is added to the sweet milk in the cheese vat. This small quantity of starter may raise the milk from .16 to .17 per cent acidity only, but it introduces into the milk a supply of bacteria that aid in improving the quality of the cheese.

Kind and Number of Bacteria in Milk

There are many bacteria in milk and cream, but the starter is used to control and to multiply the good ones whose growth forms products that give butter and cheese a desirable flavor. It is something like adding yeast to bread, as it "starts" the desired fermentation in the cream. Milk and cream usually contain a great many kinds of bacteria; some of them are beneficial, others are indifferent, and still others are positively detrimental to the good qualities of butter and cheese.

It is generally believed that the lactic acid bacteria are among the most desirable germs* for cream ripening, and for cheesemaking as they convert milk sugar into lactic acid and produce the normal souring of milk and cream. If there were no other kinds of bacteria in cream, the product made from day to day would undoubtedly have a uniformly good flavor. Other kinds of bacteria may also be beneficial, but little definite information on this point is available at the present time. Besides the beneficial and the indifferent bacteria, there are other kinds which are directly responsible for de-

*As a rule, the words bacteria and germs have the same meaning, and they are therefore here used synonymously.

fects in dairy products, among these are the "digesters" and the "gas producers." These may be present in such large numbers as to control the fermentations and overcome the growth of those added by the starter. The buttermaker and the cheesemaker should therefore make an effort to suppress the injurious bacteria and cultivate the beneficial ones. In order to do this successfully an acquaintance with the conditions both favorable and unfavorable to the growth of bacteria will be helpful. Bacteria are microscopic forms of life which are present nearly everywhere. The air of the barn and dairy is full of them, and the milk utensils which have n t been heated to the temperature of boiling water are "lined" with germs. It is also claimed that 50,000 germs have been found on one house fly. Bacteria multiply very rapidly: some produce what are called spores and others do not. These spores are not easily destroyed, it being necessary to repeatedly or continuously heat milk containing some kinds of spores to kill them. Spore-bearing bacteria are usually most plentiful around dirty barns and other filthy places; they are the cause of a great many defects in dairy products. It is necessary, therefore, in preparing skim milk for starter making, to heat the milk to a high temperature, near the boiling point, for one-half hour or more, in order to kill the spore-bearing bacteria present, which if not destroyed will grow and spoil the starter. The effect of the putrefactive and other objectionable products formed by the spore-producing bacteria may be largely neutralized by getting the acid-forming bacteria to grow in the starter as soon as possible. The spore-bearing bacteria do not grow well in milk containing a large number of lactic acid bacteria.

Necessity of Thorough Heating. It is very essential that the foundation* skim milk should be nearly germ-free, as any undesirable bacteria that may have been left alive in it after heating will grow and multiply as fast as the desirable ones which have been added in the form of a pure culture; the products formed by the growth of these undesirable bacteria may be the cause of some defects in the butter or cheese. If, on the other hand, the skim milk is very clean,

*Besides skim milk, whole milk, and cream, such milk products as unsweetened condensed milk and milk powder may be used for the foundation material in starter making.

heating to a temperature of 150 degrees F. is sufficient to kill all the bacteria in it. Repeated heating to a high temperature will aid in reducing the number of bacteria and of spores. Some of the spores will survive one heating. This is especially true of the putrefactive bacteria which may be the cause of serious defects if they are not held in check.

When the foundation skim milk is made as nearly germ-free as possible by heating, the can is covered with an overlapping cover and cooled.

Cooling the Skim Milk. The cooling is done in any convenient way, either by allowing cold water to run around the hot can or by setting the can in a refrigerator. Stirring while cooling will hasten matters, and the more quickly the cooling is done the better it will be for the starter, as sudden cooling checks the development of the spores which may have lived through the heating.

When the skim milk has cooled to 80 degrees F., the pure culture is added to it. This pure culture may be a small quantity of some sour milk which has been selected and allowed to sour naturally, or it may be a bottle of solid or liquid commercial culture which has been prepared for this purpose.

The prepared seed or pure culture grown in a small quantity of sour milk which is to be added to the carefully prepared soil or pasteurized skim milk is often called the "mother" starter or "startoline."

Best Condition of Starter for Use. The starter ought to be used before there is a separation of whey from the curd, as a coagulated starter is too sour for producing the best results. The object of a starter is to propagate the largest possible number of selected bacteria in a vigorously growing condition; and from our present knowledge it is supposed that this point is reached just as the milk coagulates and before the whey separates from the curd.

The method of controlling butter and cheese flavor by means of a starter may seem to be an easy one to follow, but in general dairy and creamery practice it has been found that there are many ways in which the starter or the pure culture becomes contaminated with undesirable bacteria. These are introduced so easily by careless handling from day to day

and by a lack of knowledge regarding the propagation of starters, that it is important to understand not only the mechanical manipulations, or how to make a starter, but also the reasons for each step taken in their propagation.

Selecting the Starter. The first thing to learn about starter-making is how to transplant desirable ferments from one day to another into the sweet cream or milk without introducing a great many undesirable bacteria at the same time.

Another important point in starter-making is the skillful selection of a desirable starter. This knowledge is obtained by close observation and by training the senses of taste and smell to distinguish a good starter from a poor one. The ability to detect the peculiar odor which experience has shown to be characteristic of a good starter and to determine whether or not it will injure or improve the product is more easily acquired by some people than by others. Some people have a very acute taste and a keen sense of smell; they can tell instantly whether a starter will give good or bad results. This acuteness is often a natural gift, but nearly all persons may cultivate it by a systematic training obtained from daily observations regarding the effect which certain starters have had on the butter or cheese.

A sharp, clean, acid taste with no trace of an offensive odor is about all that can be given in the way of description of the desirable flavor to be sought for in selecting a starter.

Vigor of the Starter. Another thing to be considered in starter-making, besides the purity of the culture, is the vigor and the thriftiness of the ferments which have been selected. A weak or enfeebled growth of even a desirable culture may not produce good results and an effort should be made to provide conditions favorable for a vigorous development of the bacteria wanted. The growth of bacteria in a starter may be compared with that of vegetation. When plants are transplanted in a greenhouse or graden, the strong and thrifty ones get started more quickly and grow better than those which are weak and feeble. The same thing is true of bacteria; the healthy, vigorous germs develop quickly, and bring about the changes in milk which are peculiar to them much more rapidly than is the case with wilted and en-

feebled bacteria. The garden plants may be sorted over and the vigorous specimens selected for transplanting, but there is no similar means of detecting the hardy bacteria. The buttermaker and cheesemaker must form his opinion of them from the acidity and age of the starter, as well as the temperature at which it has been kept and the rapidity with which it has soured.

Acidity of the Starter. It is a well known fact that the vigor of bacteria is diminished by an accumulation of their own products, one of which in the case of milk and cream is lactic acid. When the acidity of milk has reached 0.8 per cent, the bacteria cease to multiply rapidly, and those present in such a strongly acid milk are greatly reduced in strength and vigor. The starter is therefore supposed to be in its best condition for use before the acidity has reached 0.8 per cent; about 0.6 per cent acid is probably a more favorable stage of acidity than 0.8 per cent. This amount of acid (0.6 per cent) is often developed before milk coagulates; better results will therefore be obtained by using the starter just before rather than after it has curdled or wheyed off.

Thus, as we see, the two things most needed in a starter are, first, a large excess of some desirable kind of bacteria, and, second, a vigorous and healthy growth of the bacteria which have been selected.

Amount of Starter to Use. No fixed rule can be given for determining the quantity of starter that ought to be used in each lot of cream. The condition of the milk and cream and of the starter must be considered in estimating the amount needed. A quick ripening of the cream is aided by a large starter and a slow ripening is obtained by using a small quantity; a thin cream needs less starter than a thick cream, and the sourness of the starter itself is of importance. In a general way it may be said that the amount of starter to be recommended in the summer, when the cows are on grass, is from five to ten pounds of starter per 100 pounds of cream. This amount is usually added to cream testing about 30 per cent fat. In the winter, when cows are milked in the stable and receive dry feed, good results have been obtained by skimming a cream testing 40 to 50 per cent fat and using at

least 25 per cent of starter. The flavor of the butter may also be benefited by the addition of clean and sweet morning's milk to the cream.

Stirring the Starter. In the early stages of starter making it is often necessary to stir the skim milk in order to aid in uniformly heating it and also to mix the pure culture thoroughly with it. No harm will come from this early stirring before the starter has soured, but when all the necessary mixing and heating has been done, the starter should not be disturbed. It should be allowed to coagulate quietly.

The sour curd is often run through a hair sieve to remove any hard lumps that may be present. Curd lumps in a starter are often caused by stirring it after souring, and on this account directions are usually given to omit stirring after the first necessary mixing of the pure culture with the skim milk.

Sterilizing Utensils, Care of Starters, Etc.

On account of the wide distribution of bacteria in the air, water, and flying dust, it is extremely important that all the utensils used in starter-making should be completely sterilized. The time and attention given to starter-making may be entirely thrown away and the starter ruined by any neglect in this direction.

The cans, buckets, dippers, stirrers, cloths, covers, and everything used in the preparation of a starter should be thoroughly steamed after they have been washed and rinsed with clean water. A steaming box or oven may be provided for this purpose and the tinware should be heated in it to a boiling temperature for at least one-half hour. An exposure of the starter or of the cans to the air, by leaving them uncovered, or by rinsing the cans with water which has not been boiled, may spoil the work already done, and it is therefore very important that every precaution possible should be taken to prevent the contamination of the pure culture with undesirable bacteria. Even the operators' hands should be rinsed in clean water and he should also avoid putting his hands inside the cans, pails, etc., after these utensils have been sterilized. The cans used for holding the starter ought to have covers made with overlapping sides that fit outside instead of inside the can walls.

Bacteria are so numerous and so widely distributed that in starter-making it is safe to assume that they are always growing on anything which has not been previously heated to a sufficiently high temperature to destroy them. On account of the susceptibility of a starter to outside contamination, it is always safest to skim off and throw away the top layer of an inch or more. This often contains some undesirable bacteria that have found their way into the can in spite of all precautions to keep them out.

General Precautions Regarding Starters

Strict rules in regard to temperatures and the length of time that the starters must be kept at definite temperatures cannot be safely followed from day to day. The maker must use his judgment in regard to the best conditions necessary for developing the starter in each case.

1. If the starter is not wanted for immediate use, and it has already become sour, it may be kept a few hours by cooling to a temperature of 50° F., or lower, and if the milk does not sour fast enough it should be warmed in order to hasten the souring process.

2. If the starter is spongy and gassy, the skim milk has not been properly pasteurized, or else it was obtained from tainted milk. Such a starter should be thrown away and a new one made from perfect milk.

3. Whole milk may be used for starter-making instead of skim milk, and the milk from fresh cows or those in the early stages of their milking period is preferable to that of strippers.

4. Nothing need be feared from a cooked flavor by heating the foundation skim milk to a high temperature. This will disappear before the starter is ready to use.

5. Do not let the starter get over ripe, and remember to save a bottle of mother starter or startoline each day for seeding the fresh lot of pasteurized milk which makes the starter for the next day.

6. More benefit will usually be obtained from a starter in pasteurized than in raw or unheated cream or milk.

7. The bottles or packages of pure culture should be kept in a cool place protected from strong light until they are used, and not opened until everything is ready for emptying the contents into the pasteurized or sterile skim milk in which the culture is to be grown.

8. By careful handling, a pure culture may be carried along and used daily for weeks and months, but until one becomes expert in handling starters it is best to begin a new one each week, as the starter may degenerate from the impurities which get into it from day to day.

9. In developing a starter the bottles of milk should be kept at a constant temperature until soured sufficiently; then cooled and kept cold until added to the pasteurized milk. Too high a heat, about 130° F., will kill the lactic acid germs in the starter, but cold does them no harm.

10. Always pour out some of the starter into a cup for examination, and never place a thermometer, pipette, or spoon in the starter after it is made, although these must be used in the early stages of the process.

11. Every effort possible should be made to protect the carefully soured milk from contamination after the pure cultures have been added and a good growth of lactic acid germs is obtained.

Cottage Cheese Making

Cottage cheese is a nutritious palatable food for which there is a good demand, provided the quality of the cheese is uniformly good from day to day.

It is sometimes assumed that making cottage cheese is a very simple process. This is true if the sweet skim milk is simply allowed to sour, the curdled milk is stirred until the whey separates and this is drawn off, leaving a mass of curd in the bottom of the can or vat.

The objection to this simple method of making cottage cheese is that it does not give a satisfactory product every time. If the curd is stirred too much in the whey, the cottage cheese will have a tough, rubbery texture, or if the whey is too sour it may be too dry and have a mealy texture. This is

not the kind of cottage cheese that makes the consumer ask for a second package.

The principal thing to keep in mind in making good cottage cheese is the souring of the milk to the right point and the handling of the lumps of curd in the whey before this is drawn off. The consumer likes a soft texture and an agreeable, fresh flavor in cottage cheese. These may be obtained if the skim milk is allowed to sour to just the right acidity before the curd is cut and then the pieces of curd are kept as large as possible while gently stirring them in the whey before this is drawn off.

After drawing off the whey from the large lumps of soft curd, a sufficient amount of cold water should be added to cool the curd thoroughly. This cold water chills the surface of the curd and prevents it from becoming tough and hard.

After allowing the curd to stand in the cold water a few minutes the water is drawn off, leaving the curd in the bottom of the vat where it is salted and made ready for the packages in which it is to be sold.

A method of cottage cheese making that gives uniformly good results may be outlined as follows:

1. To the sweet skim milk of .2 per cent acidity or less, add about 15 per cent of a previously prepared sour milk or starter.
2. Heat the mixture of skim milk and starter to about 100° F.
3. Allow this skim milk and starter to stand quietly until it reaches about .6 per cent acidity.
4. As soon as the skim milk has soured to the right acidity, begin heating the curd and cut or stir it in the whey for about 15 minutes.
5. When a small portion of the curd has a soft, mellow feeling in the hand, begin drawing off the whey.
6. After drawing off all the whey, add enough cold water having a temperature of about 50° F. to cover the curd in the vat.

7. After the curd has stood in the cold water about 15 minutes, draw off the cold water.

8. The curd now left in the bottom of the vat may be salted at the rate of one and one-half pounds of salt per 100 lbs. of curd.

9. The yield of cheese by this treatment should be about 12 pounds of cottage cheese per one hundred pounds of skim milk.

CHAPTER III

Butter Yield and Overrun

The amount of butter made from either milk or cream depends on:

1. The richness of the milk or cream.
2. The manufacturing losses.
3. The composition of the butter.

The manufacturing losses include the butterfat left in the skim milk, the buttermilk and the losses by waste of milk and cream that sticks to the empty cans, the weigh can, the conductor pipe, the walls of the milk vat, the separator bowl, the skimming pans, the cream ripening vat, and the small pieces of butter left in the churn.

It is surprising to note the effect these small losses have on the actual yield of butter, especially at a small factory. The larger the factory the greater the need of watchfulness to reduce these losses to their lowest terms and thereby increase the yield of butter.

Yield of Butter from Milk

By tracing the fat in ten thousand pounds of milk testing four per cent fat, it is possible to show just what losses take place in the skimming, the churning and the waste of milk, cream and small pieces of butter during the entire process of manufacturing the butter.

Ten thousand pounds of milk multiplied by four per cent fat gives 400 lbs. of butterfat, and when the milk is skimmed we may get the following:

	1,200 lbs. of cream
	8,700 lbs. of skim milk
	100 lbs. of milk wasted
Total	10,000 lbs. of milk

Skimming Losses

We will assume that the 8,700 lbs. of skim milk tested .05 per cent fat, then multiplying 8,700 by .05 per cent fat we get nearly 4.5 lbs. of fat. By multiplying the 100 lbs. of milk that is lost during the skimming of the 10,000 lbs. by 4 per cent, which is the test of the milk, we get 4 lbs. of fat, making the loss in skimming 4.5 lbs. of fat in the skim milk and 4 lbs. of fat wasted, a total loss of 8.5 lbs. of fat, which subtracted from the 400 lbs. of fat in the original milk leaves 391.5 lbs. of fat left in the cream.

It is an easy matter now to calculate the test of the cream if we wish to do so. In this particular instance we had 1,200 lbs. of cream and 391.5 lbs. of fat. The per cent is calculated as follows:

1200 : 391.5 :: 100 : X
391.5 x 100 = 39150.
39150 ÷ 1200 = 32.6 the test of the cream

The next step is to churn this cream and find the churning losses.

The weight of the buttermilk may be calculated by subtracting the 391.5 lbs. of fat from the 1200 lbs. of cream, which gives 808.5 lbs. of buttermilk.

Assuming the test of this buttermilk to be .2 per cent, we find the losses in the buttermilk to be:

808.5 x .2% = 1.61 lbs. of fat

The losses from waste in churning we will assume are 2 per cent of the fat in the cream. This seems like a large figure, but we will carry the calculation through and see how we come out.

If we have 391.5 lbs. of fat in the cream, and 2 per cent of this is lost by failing to rinse out the vat thoroughly and by failing to save all the small pieces of butter when removing it from the churn, we find that this 2 per cent of 391.5 lbs. is 7.83 lbs. wasted.

Adding together the churning losses, we have 1.61 lbs. of fat in the buttermilk, plus 7.83 lbs. fat wasted gives a total loss in churning of 9.44 lbs. butterfat.

If now we had 391.5 lbs. of fat in the cream churned, we must subtract 9.44 lbs. fat lost in churning, which leaves 382.1 lbs. fat that went into butter.

The amount of butter which this weight of butterfat will make may easily be found by assuming that we want butter containing 82 per cent fat, and using the figures in the following proportion:

82 : 100 :: 382.1 : X X = 466 lbs. butter

We find, therefore, by summarizing all the calculations in connection with the skimming and churning of the 10,000 lbs. of milk testing 4 per cent fat, that from the 400 lbs. of fat in the milk we made 466 lbs. of butter and the butter contained 82 per cent fat.

The *overrun* in this case may be calculated by subtracting the 400 lbs. fat in the milk, from the weight of butter, 466 lbs., which gives 66 lbs. of overrun, and the percentage overrun may be obtained by the following proportion:

400 : 66 :: 100 : X X = 16.5% overrun

This 16.5 per cent overrun is about the standard figure recommended in years past as the average butter overrun from milk when all the losses from the skimming of the milk to the finished butter are taken into consideration.

It can be shown however, that this overrun may be increased by saving some of the mechanical or waste losses of fat in the butter making process

It will be remembered that when skimming the 10,000 lbs. of milk, our calculation included 100 lbs. lost during the skimming process; this representing 4 lbs. of fat, the first waste or mechanical loss.

The second mechanical loss was in churning the cream. This represented the loss of cream by failure to save the vat rinsings and the loss of small pieces of butter in churning, all of which in our calculation, amounted to 2 per cent of the fat in the cream or in this particular case 7.83 lbs. of fat.

If now we add the 4 lbs. of fat lost in skimming and the 7.83 lbs. of fat wasted in the churning process, we will have a total mechanical loss, or loss by waste of 7.8 plus 4 lbs. or 11.8 lbs. butterfat.

The percentage this mechanical loss is of the fat in the milk we started with is shown by the following calculation:

400 : 11.8 :: 100 : X X = 2.9% mechanical loss

Most of this loss could be saved by careful work and the yield of butter would be increased in this case by 11.8 lbs., which, added to the 382.1 lbs. butterfat used in the above

calculation, gives 393.9 lbs., and this, according to the following calculation will make 480 lbs. butter, containing 82 per cent fat.

82 : 100 :: 393.9 : X X = 480 lbs. butter

The overrun will therefore be 20 per cent instead of 16.5 per cent

400 : 80 :: 100 : X X = 20% overrun

This shows that it is theoretically possible to get a 20 per cent overrun in buttermaking from milk when there are no mechanical or waste losses and only a small loss in the skim milk and the buttermilk.

Summarizing all the losses in this calculation, we have the following:

Skim milk loss.....4.5 lbs. fat.
Buttermilk loss.....1.6 lbs. fat.

Total .....6.1 lbs.

Mechanical losses in skimming.....4.0 lbs. fat.
Mechanical losses in churning .....7.8 lbs. fat.

Total .. ..11.8 lbs.

Total Losses in Manufacturing ..17.9 lbs.

The careful operator may save a large part of the 11.8 lbs. loss and thereby increase the yield of butter and the overrun from 16.5 per cent to 20 per cent, where the overrun is calculated from the fat in the milk.

Overrun from Cream

When butter is made from cream the skimming losses are eliminated and this gives a larger overrun than is possible when butter is manufactured from milk.

In the calculation given we had 1,200 lbs. cream testing approximately 32.5 per cent fat equal to 390.0 lbs. butterfat.

If we churn this cream and take into consideration the losses in buttermilk only, (1.6 lbs. fat), we will have recovered in the butter 390.0 minus 1.6 lbs. fat, or 388.4 lbs. fat, and this

will make 473.67 lbs. butter containing 82 per cent fat as shown by the following proportion.

82 : 100 :: 388.4 : X X = 473.67

The overrun in this case is calculated by subtracting the pounds of fat in cream, 390.0, from the pounds of butter, 473.67, which gives 83.67 lbs., and this is 21 per cent overrun because 83.67 is 21.47 per cent of 390.

390.0 : 83.67 :: 100 : X X = 21.47%

Excessive Overrun

The overrun and the yield of butter may be still further increased by making butter containing 80 instead of 82 per cent fat, as follows:

80 : 100 :: 388.4 : X X = 485.5

and 485.5 minus 390.0 is 95.5 lbs. overrun, which is

390.0 : 95.5 :: 100 : X X = 24.5%

This 24.5 per cent overrun assumes one loss only in making butter from cream, that is, a buttermilk test of .2 per cent fat.

It is unreasonable to expect that cream can be churned without some mechanical losses such as particles of cream and butter that will inevitably stick to the cream vat, churn and other utensils used in churning, and further the butter will not always contain exactly 80 per cent fat, so that taking into consideration all the possibilities of most careful work, accurate testing and legal butter making, an overrun of about 23 per cent may be considered satisfactory in the every-day work of a creamery and an overrun of 25 or even 24 per cent is an suggestion of some error in testing or weighing or in the fat content of the butter.

Overrun from Salted and Unsalted Butter

In one hundred pounds of salted butter we will have approximately 81 lbs. of fat, 3 lbs. of salt, 15 lbs. of water and 1 lb. of curd. If this butter sells at 40c a pound, we will receive $40.00 for this 100 lbs. of salted butter. Now divide this $40.00 by 81, the pounds of fat in the butter, and we get 49.38c as the price we will receive per pound of fat for salted butter when sold at 40c a pound.

In 100 lbs. of unsalted butter, we will have approximately 15 lbs. of water, 1 lb. of curd, 84 lbs. of fat. Dividing the

$40.00 by 84 gives 47.61c per pound of fat as the price received for the fat in the unsalted butter. This is a difference of 1.77c per pound of fat in salted as compared with unsalted butter.

The difference in overrun is shown by the following figures:

In salted butter we have 19 lbs. of substances not fat for every 81 lbs. of fat. This is the same as 23.4 lbs. of overrun for 100 lbs. of fat. That is:

$81 : 19 :: 100 : X \qquad X = 23.46\%$ overrun

In the unsalted butter we have 16 lbs. of substances not fat to every 84 lbs. of fat, and by the same calculation:

$84 : 16 :: 100 : X \qquad X = 19$ per cent overrun from unsalted butter.

If the buttermaker is making salted butter and selling it at a certain price, a change to making unsalted would necessitate his getting about one and three-quarters cents per pound more for unsalted than for salted butter. In this calculation no estimate is made of the cost of the salt or of the color added to the salted butter.

Butter Over-run

Butter over-run irregularities may be caused by:

1. Losses from either too rich skim milk or too rich butter milk.
2. Losses from waste of milk, cream and butter which may adhere to the separator, cream vat or churn.
3. Losses in selling weights, i. e., receiving pay for less butter than the shipment weighed at the factory.
4. Inaccurate cream weighing and butter weighing scales.
5. Disagreements between the butter buyer's weights and the creamery weights of butter sold.
6. Inaccuracies in sampling the cream for testing.
7. Lack of sensitiveness in cream testing scales.

8. Failure to use a tempering water bath for reading the cream tests.
9. Variation in water content of the butter.
10. Variation in the fat content of the butter.

Remedy: In seeking a remedy for low over-run, a high over-run or for an inexplainable variation in the over-run from day to day it is best first to test the buttermilk, then observe the care taken in transferring the cream from the ripening vat to the churn as well as the removal of the butter from the churn to the selling package and note whether there is any loss from waste in these operations, then compare the scales used for weighing the milk or cream bought, as well as those on which the butter is weighed when it is sold. The scales may be right, but those of the buyer of the butter may not correspond with the creamery scales and the differences in weights of butter paid for, as compared with the amount of butter supposed to be sold from the factory may be an important feature in figuring the over-run.

Difficulties in getting the right over-run may also be due to the condition of the cream when it is sampled.

All the cream bought should be free from lumps and in a smooth condition when sampled. If it is not, the cream should be poured through a strainer before sampling it. The strainer will take out the lumps and make it possible to get an accurate sample, which will not be the case if lumps are left in the cream.

The cream testing scales should always be kept dry and in a covered box when not in use, while the test bottles containing the completed cream tests should stand in a water bath having a temperature of about 140° F, for at least 10 minutes before the fat tests are read.

The moisture and the fat content of the butter should be determined in every churning, as these will show whether or not the butter contains too much or too little fat. This is often an important feature in calculating the over-run.

Either a high or a low over-run is cause for action on the part of some one interested in the buttermaking and an investigation will probably reveal the reason for an abnormal over-run.

CHAPTER IV

Cheese Defects and Factory Payments

What Is Good Cheese?

A Letter and a Reply

"I send my appreciation of the cheese which has just arrived.

"My wife and I say that is 'some cheese.' It touches just the right spot to add zest and flavor to mush and milk, bread and milk, or any old kind of pie. My daughters say it is too strong, but they don't count. I notice they are doing their full share. My son-in-law runs a corn husker and had taken his dinner where they had good full cream cheese on the table on the day your cheese arrived and he had found out, he told me at night, where it was made. He said he liked the crumbly kind. I told him that we had just got that kind of cheese and, like Jack Spratt and wife of the old nursery rhyme, we of course, always 'licked the platter clean.'

"When I was a boy, my father ran a dairy of about 50 cows, and my mother made cheese for the market. All one kind as near as she could make, and of course always full cream. All one kind, except once in a while a sage cheese for local consumption. Now the point I am getting at is that I look at the wholesale cheese market and I find nine kinds of cheese quoted (and other kinds might be quoted). Most of the names might about as well be in a foreign language I have never studied, having the Latin characters for letters. I want to know and talk as understandingly of flats, daisies, longhorns, etc., as I do of brick or limburger and what I desire to know is the process of making and of curing all these different kinds of cheese. That probably comes under cheese making.

"Let me cite a concrete illustration. About a month ago a man advertised in a paper, brick cheese for sale by parcel post. I sent for one. He wrote me that since printing the "adv." the price of cheese had advanced and that he had sold himself short, but that he would mail my cheese on a certain day the next week. The cheese came as per advice. Our

curiosity and appetite were whetted. The cheese was positively almost tasteless. We made believe we were eating cheese till your cheese came. My housekeepers seem to think now we have a small white elephant on our hands in the shape of that tasteless cheese. I tell them to put a cheese cloth on it, cover it with paraffine and set it away to wait developments.

"I shall have my friends sample your cheese and I intend to send you an order in the near future.

"Your cheese is the kind I have had in my mind's eye for many years but could never buy it."

Reply: I know there are scattered through the universe people like yourself who want cheese that has a cheese flavor and something more than tasteless milk curd. I am so fond of this old cheese that I keep in our curing rooms a good supply of it all the time for filling orders from people who have learned that we have it in stock and when they once learn, they never cease to order this cheese in the future.

It is a very interesting fact, however, that what I may call a majority of the cheese consumers (that is, people who go to a grocery store and buy a pound of cheese once a month for some reason or other, not because they like cheese, but they see it in the store and think they ought to have some) want a piece of cheese that is soft and leathery and in my opinion somewhat indigestible; it has no more taste than blotting paper, but since it is what some people want they of course must be supplied.

I am inclined to think, however, that if our cheese factories would make an effort to educate the people as to what is a good cheese, that they would demand it just as much as they demand any other good food which they like because of its characteristic flavor.

I had an interesting illustration recently of the general public taste for cheese. One of our stenographers called my attention to the fact that some woman had just returned a cheese to our Dairy School salesroom and said that it was a disgrace to the institution to send out such cheese. I immediately went to the salesroom and asked to see the cheese which had been returned. I found it to be a brick cheese which looked all right on the outside, but when it was cut in two there was a thin line of mold about the thickness of the

blade of a knife through the center of the cheese. This of course was what scared the ladies. I thought, however, it might be a good plan to try this cheese and I was surprised to find that it had the flavor of the finest kind of Roquefort cheese. I gathered it all up, paid the salesman and took the cheese home, giving some of it to my friends, telling them it was from France and cost $1.00 a pound. They all agreed with me that this was the finest cheese they had eaten for many a moon, and wanted to know why we didn't make Roquefort cheese in this country, saying that they would be glad to pay 75 cents a pound for such cheese if they knew where to get it.

This cheese was made by Dairy students and kept in our Dairy School curing room for about a year. It was soft; it had the texture and flavor of Roquefort cheese, but the party who got it from the salesroom thought she had been imposed on because she paid 30 cents a pound for cheese in which she found a few spots of blue mold, and I have no doubt whatever but this same piece of cheese, if sold at some fancy grocery and called imported Roquefort cheese, would easily have sold for 75 cents a pound, and there would be a good demand for it if such cheese could be obtained.

A little while after this episode a man came into my office with half of a five pound cheese which he had bought at our salesroom and said it was entirely too strong for him, asking if he could return it. I said "certainly you can return it, but I doubt if we have in our cheese curing room a cheese fresh enough to suit you." I gave the piece of old cheese back to our salesman and we finally found a piece of new cheese about six weeks old which just suited the taste of this man.

After he left I inspected the cheese he returned and found it had the old Cheddar flavor which is so much sought for by a certain class of people who like cheese because of its cheese flavor and who would be glad to pay at least 50 cents a pound for cheese of that kind.

I do not know as it is possible to educate the millions of people in this country to learn what really good cheese flavor is, but I am sure that if they once get started it would be pretty nearly as difficult to break the habit of demanding this old cheese of our grocery stores as it was to abolish saloons.

In regard to your question about developing the desired flavor in new cheese, I think that all you need to do is to dip a good cheese in paraffine, and place it in your cellar or in some cold room for about six months. You will find, of course, that the cheese will mold on the outside, but never mind that, let it mold, and when it is old enough you can easily wash off this mold and the interior of the cheese will have that characteristic cheese flavor which you will easily recognize.

Bad Flavors in Cheese

Bad flavors in cheese may be caused by:

1. Sour milk pails, or milk cans.
2. Failure to cool the milk at the farm before delivering it to the factory.
3. Leaving the milk at the farm near the cow stable where it absorbs a stable odor.
4. Abnormal cow feed, such as weeds, that do not give a good flavor to milk.
5. Some of the fly mixtures used on the cows during milking time.
6. Using a starter that has a poor flavor.
7. Vats, and other utensils in a cheese factory that have not been thoroughly cleaned and scalded each day before using them.

Remedy: Bad flavors in cheese may be overcome by scalding with boiling water all the milk utensils used at the farm after these are thoroughly washed. All the milk cans, pails, etc., should be allowed to stand in a clean, dry place, protected from dust, until the next milking.

The milk of sick cows and cows having diseased udders or defects of any kind should be rejected, and the udders of all cows washed with a damp cloth before each milking.

High flavored feed such as turnips, cabbage, beets, should be fed after milking if it is necessary to feed them at all.

The milk should be removed from the cow stable immediately after milking, then cooled quickly, and held in cold water in the milk house until it leaves the farm.

If a milking machine is used this should be carefully cleaned and sterilized after each milking; the tubes kept in a solution that is free from bacteria and this solution changed frequently. Just before milking the entire milking machine, including all the tubes, should be thoroughly rinsed with clean, cold water. Milk from morning and night should not be mixed, but kept separately until both are cooled.

The cheesemaker should use as much care in cleaning his own weigh can, vats, etc., and in selecting his starter, as he expects the farmers to use in caring for the milk delivered to the factory. A good example in cleanliness to the patrons is always impressive.

Checked Rinds in Cheese

Checked rinds in cheese may be caused by:

1. Pressing the cheese when it is too cold.
2. Failing to mellow the cheese sufficiently before salting.
3. Insufficient pressure while the cheese is in press.
4. Press cloths that may be stiff and not pliable.
5. Hoops and followers that do not drain well.
6. Greasy curd.

Remedy: The cheese curd should be put into the hoops and placed in press as soon as the curd has well mellowed after salting. It is a good plan to warm the hoops and the press so that these are not too cold when the cheese are put to press. The temperature of the press room should not be below 60° F.

The cheese press cloths should be kept clean, as dirty, stiff cloths prevent drainage from the cheese during the pressing process. Cheese should always be placed in a continuous press and held for 15 to 20 hours.

Crooked Cheese

Crooked cheese may be caused by:

1. Followers that do not fit together well.

2. Cheese hoops not evenly filled.
3. Hoops touching on a rough press bed.
4. Applying pressure too quickly to the cheese in the press.
5. The head block of the press may be set crooked.

Remedy: These defects may be overcome by filling the hoops evenly so as to give a smooth surface to the cheese, and then taking time enough to fill the hoops in a satisfactory way.

When the hoops filled with curd are placed in the press the condition of the head block should be noticed, and if this is not straight a little time should be taken to repair the head block and make it satisfactory in all respects.

Pressure should be applied carefully in the press, taking time enough to apply the pressure slowly and evenly.

If cheese are crooked they can be straightened by reversing them in the press.

Defective Cheese Bandages

Defective cheese bandages are either:

1. Dirty
2. Torn
3. Too long
4. Too short
5. Wrinkled

These defects may be easily overcome by carefully inspecting each bandage before it is used. If the so-called "bolt" cloth bandage is used these should be cut square and not on the bias.

Dirty bandages should be discarded and not used at all, unless they can be cleaned.

The length of the bandage is a point which may be easily noticed, and one of appropriate length provided. All bandages should fit tightly with no wrinkles. This may be remedied when the cheese are dressed after pressing.

In boxing cheese the bandages are sometimes torn by carelessness in handling them.

Dry Texture in Cheese

Dry texture in cheese may be caused by:

1. Making cheese from partially skimmed milk.
2. Developing acid too slowly.
3. Using too high a cooking temperature.
4. Cutting the curd too fine for the time required to develop the acid.
5. Agitating the curd too long a time in the whey, especially when the last of the whey is drawn off.
6. Allowing too much acid to develop.
7. Adding too much salt to the curd.
8. Holding the cheese in too hot and too dry a curing room.
9. Failure to pile the curd high enough or fast enough in the cheddaring process.

Remedy: The cheesemaker should always refuse to take in milk that is a trifle over-ripe, as one lot of acid milk may spoil the good cheese that could be made from the sweet milk delivered by other patrons.

When the cheesemaking process has begun the curd should be firmed at as low a temperature as possible in the whey, and if the cheese is uniformly rather dry at a certain factory this may be overcome by drawing the whey from the curd a little sooner than is the usual practice at that factory. The curd should be stirred gently in the whey and only a long enough time to keep the curd particles separated.

Dry texture may also be avoided by developing less acid in the whey, piling the curd quicker and in longer piles during the cheesemaking process, and avoid using too much salt, as the less salt the better the texture, although it is necessary to add sufficient salt to give the cheese the required flavor.

The curing rooms must in all cases be kept cool and moist in order to prevent the cheese from drying out before it is delivered to the buyer.

Excessive Moisture in Cheese

Excessive moisture in cheese may be caused by:

1. Over-ripe milk, which works so fast in the cheese vat that the curd may not be properly firmed.
2. Cutting the curd too coarse for the temperature and time used for firming.
3. Failure to keep the curd from lumping while in the whey.
4. Irregular stirring of the curd in the whey, and heating too fast.
5. Holding the curd at too low a temperature after removing the whey.
6. Using too little salt.
7. Soaking the curd in water before salting it.

Remedy: Refuse the over-ripe milk from your patrons, and ripen the milk in the cheese vat slowly.

Cut the curd when it is just hard enough to cut easily and not too soft to cut with a knife, and after cutting, stir the curd gently with the hand until it is loosened from the sides and bottom of the vat and also until it is firm enough to stand the stirring with the rake.

As the curd becomes warm increase the rapidity of stirring with the rake, because allowing the curd to lump or the lumps to become uneven in size at any time while in the whey, will permit some of the curd to become firmer than other parts of the curd, giving an unevenness to the softness of the curd in the whey.

This unevenness in the softness and hardness of the different lots of curd in the whey results in a loss of solids and of yield in cheese.

If water is needed to wash the curd before salting, it is added:

1. To remove the free fat drops on the surface of the curd.
2. To cool the curd and in this way reduce the possibility of a gassy curd somewhat.

When the curd is stirred in the vat to prevent the lumps sticking together, this stirring must be carefully done and the temperature not allowed to go below 80° F. In salting the curd use 2.5 to 3 pounds of salt to each 100 pounds of curd.

Gas Holes in Cheese

Gas holes in cheese usually have a uniform outline with smooth walls. They may be caused by:

1. Careless handling of the milk at the farm before it reaches the factory.
2. Failure to scald the milking utensils.
3. Using a starter that is not a pure culture of lactic acid.
4. Holding the curd at too low a temperature after drawing off the whey.
5. Too warm a curing room.

Remedy: Carefully inspect the milk received at the factory in order to make sure that it all has a clean flavor, and never use a starter unless it has a clean, acid taste and and is free from any objectionable odors. Add the starter as soon as possible after the milk is in the vat and begin the heating of the milk at once so as to promote the rapid growth of the favorable bacteria in the starter.

Do not allow the temperature to drop too low during the time whey is drawn off and up to the time of salting. This will help the development of the acid which will check the growth of bacteria that are responsible for the gas holes.

The principal cause of this defect in cheese is the condition of the milk when it reached the factory. Every farm should be provided with an arrangement for scalding the milk pails, milk pans, milk strainer, etc., and the cows milked with clean dry hands and the milk cooled and set in a cold water tank until it is delivered to the factory.

Greasy Texture in Cheese

Greasy texture in cheese may be caused by:

1. Old milk that may be sweet but some of the cream has risen on it before delivery to the factory.

2. Setting the milk at too high a temperature.
3. Careless matting of the curd.
4. Rinsing the curd with too warm water before salting it.

Remedy: If milk is delivered to the cheese factory every other day in cold weather it should be stirred occasionally at the farm to prevent the cream from rising on it before it is delivered to the cheese factory, and warm milk should not be mixed with cold milk at the farm.

If small granules of butter are noticed on the surface of the milk in the vat at the factory, these should be skimmed off before the milk is made into cheese.

The curd should not be matted too soon in the vat, and if it is necessary to rinse the curd before salting in order to remove the surplus fat that may be noticed in the curd, this rinsing should be done with water having a temperature of about 60° F. and the curd well drained before it is salted.

High Acid in Cheese

High acid in cheese may be caused by:

1. Developing too much acid during the cheese making process.
2. Leaving too much moisture in the curd.
3. Using too much starter.
4. Ripening the milk too much before adding the rennet.
5. Developing too much acid in the whey before this is drawn.
6. Failure to firm the curd enough to correct the acidity that has developed before drawing off the whey.

Remedy: Each lot of milk delivered to the cheese factory should be carefully inspected to make sure that it is not overripe or that it is sweet enough to make cheese of a good quality, and the over-ripened milk should not be allowed to run into the cheesemaking vat. The amount of starter to be

added must be regulated by the ripeness of the milk each day; one-half of one per cent starter is about the average amount needed.

The rennet should be added when the right acidity is developed in the milk and not before or after this point. Sufficient time should be allowed to firm the curd before acidity develops to such an extent that the whey has to be drawn quickly. The relation between the moisture and the acid of the curd should be watched carefully as too much acid will make an acid curd.

High Edges in Cheese

High edges in cheese may be caused by:

1. Followers that do not fit the hoops in which they are used.
2. The fibre ring being out of place.
3. The pressure being applied too quickly in the press.
4. The cheese being pressed before it becomes compact.

Remedy: These conditions may be overcome by adjusting each of the followers when filling them with curd. They should fit well and the curd pressed slowly and gradually without hurrying, as the curd will close together if given time enough. Do not dress the cheese too quickly or before it has been in the press a long en ugh time to become compact. If the curd is greasy, it may be washed with water having a temperature of about 70° while the curd is mellowing in the vat and before salting. After washing, the water and salt should be allowed to drain off and the curd permitted to mellow well before it is put to press in a room of the right temperature (about 70° F.)

Insufficient Moisture in Cheese

Insufficient moisture in cheese is caused by:

1. Cutting the curd too soon after adding the rennet or when the curd is too soft.
2. Cutting the curd too fine for the firming temperature used and for the time the curd is kept in the whey.

3. Using too much salt.

4. Keeping the cheese in a curing room that is too warm and too dry.

Remedy: The curd should be kept in the whey at least two hours from the time of setting until the whey is drawn. When the cheesemaking process is developing normally, the amount of acid that develops will determine the time at which to draw the whey.

Cut the curd when it will just break smoothly over the finger, as cutting the curd when it is too soft will break up the curd, causing it to be too firm and if this is carried too far the cheese will be too dry.

In cutting the curd the cheesemaker should be careful to get an even cut, as large pieces may dodge the knife and leave large lumps of curd in the whey. These lumps will expel their moisture slowly and by remaining in the curd when the whey is drawn off will cause white whey to run during the matting process. This is the curd that has lost some yield, and the cheese may be softer than was expected.

The temperature of the curing room should not be too high as this will dry out the cheese, and some means of keeping the moisture in the curing room should be used, as well as an instrument for measuring the humidity of the curing room air.

Lack of Firmness in Cheese

Lack of firmness in cheese may be caused by:

1. Over-ripe milk from some patron.

2. Ripening the milk too much before adding the rennet.

3. Using too much starter.

Remedy: If the milk is perfectly sweet when received by the cheesemaker he will be able to control the ripening process after the milk is in his vat and in this way get the benefit of the small amount of starter which he will find it beneficial to add to such milk.

The milk should be set as soon as possible after the heating process has begun, and set so that the curd will be ready to cut in 20 to 30 minutes.

If the cheesemaker has noticed that his cheese has not been firm enough he can overcome this by cutting the curd a little finer, either by using a finer knife or by cutting the curd several times. It is also a good plan to heat the curd soon after cutting it and raise the temperature a few degrees higher than usual.

The firmness of the curd may be improved by permitting it to mat on the bottom of the vat and stirring frequently by hand. If the curd is over-ripe, it may be rinsed with cold water, as this will remove some of the acid that has developed.

Mechanical Openings in Cheese

Mechanical openings in cheese may be caused by:

1. Insufficient acid developed in the whey.
2. Allowing the curd to become too firm for the amount of acid developed in it.
3. Failure to give the curd time enough to become mellow after salting it.
4. Too cold curd when put to press.
5. Too cold a press room.
6. Insufficient pressure in the cheese press.
7. The cheese is not allowed to stand in the press for a long enough time.

Remedy: During the cheesemaking process a uniform and exact amount of acid should be developed in the curd with a reasonable amount of moisture in the cheese. This is regulated by the temperature at which the curd is held during the entire time it is in the vat between drawing the whey and going to press.

In warm weather the curing room ought to be kept cold by opening the windows at night and closing them during the hot part of the day.

The cheese press must be kept in such a position as to give a constant pressure on the curd and hold it tightly in the

hoops. This is obtained by what is called the "continuous" press, which will close up the cheese if the temperature of the curing room is neither too warm or too cold. A uniform temperature in the curing room is very important for closing up the cheese.

Mottles in Cheese

Mottles in cheese, sometimes called *blotches,* may be caused by:

1. Uneven development of acidity in the curd during the cheesemaking process.
2. Unevenly distributed moisture in the curd.
3. Allowing the curd to lump while in the whey.
4. Permitting the curd to mat in large lumps after milling.
5. Mixing a curd of two vats or adding curd of a previous day's cheesemaking.
6. Adding starter which has curdled, and failing to strain out the lumps of curd.
7. Putting the curd to press when the cheese is too cold.
8. Allowing the cheese to freeze after leaving the press room before the moisture is uniformly redistributed through the curd.
9. Lumps of milk thickened by the rennet test that fail to take the color evenly.

Remedy: These defects in cheese may be overcome by watching every stage of the process from beginning to end. When rennet tests are made the curdled milk should not be added to the vat. Starter must be put through a strainer to take out the lumps and added before the cheese color is placed in the milk.

If the curd is matted in such a way that it becomes lumpy or uneven in texture, these hard lumps will not take the salt in the same proportion as the soft parts of the curd and this

causes the mottled appearance of the final cheese. If for any reason a higher acidity was developed in some parts of the curd than in others this will cut the color and affect the texture and flavor of the cheese as well as make it mottled.

Any treatment of the milk or the curd which produces an unevenness in the size of the curd lumps will have a tendency to make the cheese mottled, and every precaution should be taken to keep the lumps of curd in the whey as even in shape and size as possible and the entire vat of milk, curd, and whey, kept at a uniform temperature during the entire cheesemaking process.

Rind Rot in Cheese

Rind rot in cheese may be caused by:

1. Dipping cheese in paraffine before the surface of the cheese is sufficiently dried.

Remedy. Greater care in the cheesemaking process and in the paraffining process will prevent rind rot, which, if allowed to develop, may be removed by washing the cheese, then drying it thoroughly and paraffining a second time. The temperature of the paraffine should be 220° F.

Sweet or Fruity Flavors in Cheese

Sweet or fruity flavors in cheese may be caused by:

1. Returning whey from the factory to the farm in can used for delivering the milk, and failing to scald these cans sufficiently after washing them at the farm.
2. Dirty whey tanks at the cheese factory.
3. Bacteria that get into the milk either from carelessness at the farm or dirty utensils at the cheese factory.

Remedy: It has long been recommended that the cans used for delivering milk to a cheese factory should never be used for returning whey from the factory to the farm. Special cans for whey should be provided.

The condition of the whey vat at the factory is a good indication of the kind of cheese maker in the factory. A dirty whey vat is the cause of many defects which might be easily overcome if the cheesemaker would clean and steam the whey vat every day.

Seamy Color in Cheese

Seamy color in cheese is caused by:

1. Failure to cement the curd together.
2. Pieces of greasy curd.
3. Some cold particles of curd that fail to cement together and show the outline of each curd particle.

Remedy: This condition of the curd may be overcome by holding it at a temperature of 80° F. to 85° F. when put to press. If the curd is greasy, this may be removed by washing in cold water.

PAYING FOR MILK AT A CHEESE FACTORY

A full discussion of the different methods proposed for calculating the amount of money due each farmer for the milk he delivers to a cheese factory is given in textbooks such as "Testing Milk and its Products." The following comparison of two methods is made in response to many inquiries about them.

Nearly all Cheddar cheese factories have paid farmers for milk by using the results obtained with the Babcock test and the weight of the milk delivered by each patron for a given time.

The so-called "straight fat" method of paying for milk at a cheese factory is applied in the following way:

The weight of milk delivered by each patron for a given time is multiplied by the test of that milk as obtained from daily or composite samples. This gives the pounds of butterfat delivered to the cheese factory in the milk of each patron.

If payments are made every two weeks or monthly the cheese factory records will show the weight of cheese sold and the amount of money obtained for it during that time.

The expense of operating the factory for the period covered are then deducted from the money received for the cheese and the difference, or the money left, is divided among the patrons according to the weight and test of the milk delivered to the factory by each patron.

The price per pound of milk fat to be paid each patron is found by simply dividing the money by the pounds of butterfat in the milk delivered by all the patrons. This price per pound of fat is then paid to all the patrons and the amount due each one is found by multiplying the pounds of milk fat in the milk of each patron during this period, by this price per pound of fat.

The suggestion has been made that this "straight fat" method of paying for milk at a cheese factory gives each farmer credit for the butterfat in his milk without taking into consideration the casein in the milk, and since cheese contains both fat and casein, some way of paying for both fat and casein might be more satisfactory.

An illustration of the payments made to the patrons of a cheese factory according to these two methods, that is, the "straight fat" method and the "fat plus two" method, is given in the following figures:

Suppose two patrons delivered 16,000 lbs. of milk to a cheese factory and the 1,600 lbs. of cheese made from it was sold at 22c per pound, and further that after deducting the operating expenses of the factory there was left $320.00 to be divided between the two patrons.

The "Straight Fat" Method of Payment

By the "straight fat" method the two patrons will be paid as follows:

If one patron delivered 8,000 lbs. of milk testing 3 per cent fat, his milk contained 8,000 x .03, or 240 lbs. of milk fat.

If the other patron delivered 8,000 lbs. of milk testing 4 per cent, his milk contained 8,000 x .04, or 320 lbs. of milk fat.

The total fat in the milk from the two patrons is 240 lbs. plus 320 lbs., or 560 lbs. of fat in the 16,000 lbs. of milk.

If now we have $320.00 to divide between these two patrons, we will divide $320.00 by 560, and get 57.1c, which is

the price to be paid each patron for each pound of fat in his milk.

Patron No. 1 will then receive for his 3 per cent milk, 240 lbs. of milk fat, multiplied by 57.1c per pound, or $137.04.

Patron No. 2, who delivered the 8,000 lbs. of 4 per cent milk, containing 320 lbs. of milk fat, will receive 320 lbs. multiplied by 57.1c per pound, or $182.72.

Adding these two figures together, $137.04 plus $182.72, gives $319.76 paid to the patrons instead of $320.00, which was received for the cheese after taking out the factory operating expenses.

By the "straight fat" method, therefore, Patron No. 1, delivering 3 per cent milk, receives $137.04 and Patron No. 2, delivering 4 per cent milk, receives $182.72.

The "Fat Plus Two" Method of Payment

The money received by each of the same two patrons for the same amount of milk when calculated by the "fat plus two" method gives the following figures:

Patron No. 1 delivers 8,000 lbs. of milk testing 3 per cent fat, and by adding 2 to this test we have 5, which, multiplied by 8,000 gives 400 lbs.

Patron No. 2 delivered 8,000 lbs. of milk testing 4 per cent fat, which plus 2, gives 6, and this multiplied by 8,000 lbs. gives 480 lbs.

Adding together the 400 lbs. and the 480 lbs. gives 880 lbs., and the price per pound to be paid the patrons is found in the same way as before, that is, by dividing $320.00 by 880, which gives 36.3c per pound as the price to be paid each patron by the "fat plus two" method.

According to these figures Patron No. 1, delivering the 3 per cent milk, or 400 lbs. of "fat plus two" when multiplied by 36.3c per pound receives $145.20.

Patron No. 2, delivering 8,000 lbs. of 4 per cent milk, or 480 lbs. of "fat plus two," multiplied by 36.3c receives $124.24.

Adding these two figures we get, Patron No. 1, $145.20 plus Patron No. 2, $174.24, gives $319.44, instead of $320.00, the amount to be divided.

By comparing now the money received by each of the patrons according to the two methods of figuring, we find

that by the "straight fat" method the patron delivering 3 per cent milk receives $137.04, and this same patron by the "fat plus two" method receives $145.20, or $8.16 more by the "fat plus two" method than by the "straight fat" method.

These figures show that the patron delivering the richer milk gets more money by the "straight fat" method than by the "fat plus two" method, and the patron delivering the thinner milk gets more money by the "fat plus two" method than by the "straight fat" method.

It is evident therefore, that the effect of the "fat plus two" method is to encourage the thin milk producer at the expense of the rich milk producer when they are both sending milk to a factory that pays by this method. In other words, by using the "fat plus two" method the skimming or the watering of milk is encouraged, and in addition to this, thinner milk will reduce the quality of the cheese made at the factory because the richer the milk the better the cheese and the price received for the richer milk, cheese ought to be higher than that received for the thinner milk cheese.

Encourages Watering Milk

Suppose a patron delivers 100 lbs. of milk testing 4 per cent fat to a factory where he is paid by the "straight fat" method; then he will be paid for the 4 lbs. fat only, but if he adds 100 lbs. of water to the 100 lbs. of 4 per cent milk and delivers this to the factory, he will be credited with 200 lbs. of 2 per cent milk, and if this is paid for by the "fat plus two" method he gets paid for 200 lbs. of 2 per cent milk, plus two, which is 4, and 4 times 200 is 8 lbs.

By the "straight fat" method he gets paid for 4 lbs. of fat no matter whether he brings 100 lbs. of milk testing 4 per cent or 200 lbs. of milk and water testing 2 per cent fat, but by the "fat plus two" method he is paid for 8 pounds.

Taking everything into consideration, therefore, the quality of the cheese and the way in which this quality ought to affect the price of the cheese, the "straight fat" method will protect the honest farmer from any skimming or watering of the milk by another patron of the factory and will encourage the production of rich cheese.

The "Fat Plus .6" Method of Payment

Many analysis have shown that the casein content of milk does not increase in the same proportion as the fat increases, i. e., milk testing 3 per cent fat contains about 2.1 per cent casein, but milk testing 4 per cent fat contains about 2.5 per cent instead of 2.1 per cent casein.

Thin milk, almost without exception, contains more casein in proportion to the fat than rich milk.

Further, it has been found that cheese made by a uniform method from thin milk contains more moisture than cheese made from rich milk.

This is explained by the observation that casein carries with it a certain amount of moisture, and since thin milk has more casein in proportion to the fat than rich milk, the thin milk cheese contains more moisture.

The yield of cheese per pound of fat in the milk is greater for one pound of fat in milk testing 3 per cent fat than for one pound of fat in milk testing 4 per cent fat.

This difference in yield and composition of cheese made from thin and from rich milks has been noticed when both lots are made into cheese by the same process by the same man and on the same day.

It has been suggested that this difference in moisture content of the cheese made from milk of different per cents fat may be provided for and the payments for milk at a cheese factory made on the basis of a uniform moisture content in the cheese by adding .6 to the test of the milk

An application of the "fat plus .6" method of payment for the milk of the two patrons already mentioned in the previous discussion of the "straight fat" and the "fat plus two" methods will give the following figures:

Patron No. 1 delivers 8,000 lbs. of milk testing 3 per cent fat, and by adding .6 to this test we have 3.6, which, multiplied by 8,000 lbs. gives 288.

Patron No. 2 delivers 8,000 lbs. of milk testing 4 per cent fat, which, plus .6, gives 4.6, and this multiplied by 8,000 gives 368 lbs.

Adding together the 288 lbs. and the 368 lbs. gives 656, and the price per pound to be paid the patrons is found in the same way as before, that is, by dividing $320.00 by 656, which is 48.8c per pound, as the price to be paid each patron by the "fat plus .6" method.

According to these figures Patron No. 1, delivering the 3 per cent milk, or 286 lbs. of "fat plus .6" when multiplied by 48.8c per pound, receives $140.54.

Patron No. 2, delivering 8,000 lbs. of 4 per cent milk, or 368 lbs. of "fat plus .6," and this multiplied by 48.8c per pound gives him $179.54.

Adding these two figures we get, Patron No. 1, $140.54, plus Patron No. 2, $179.54, gives $320.08, the amount of money to be divided.

By comparing the amounts received by each of the patrons No. 1 for 3 per cent milk and No. 2 for 4 per cent milk, by these three methods we have:

Summary of Payments by Different Methods

Method	Patron No. 1 Milk Testing 3% fat	Patron No. 2 Milk Testing 4% fat	Total Money Divided
"Straight Fat"	$137.04	$182.72	$319.86
"Fat Plus .6"	140.54	179.54	320.08
"Fat Plus 2"	145.20	174.24	319.44

These figures show that by the "straight fat" method the highest price is paid for the richer milk, which makes the richer cheese.

By the "fat plus two" method the highest price is paid for the thinner milk.

By the "fat plus .6" method the payments are based on a yield of cheese of uniform moisture content from both rich and thin milk.

CHAPTER V

The Cause and the Prevention of Some Ice Cream Defects

The Appearance of Ice Cream

The appearance of ice cream should be:

1. Attractive.
2. Uniform in color.
3. Appetizing.
4. Smooth grained.
5. Not partly melted.
6. Not too highly colored.
7. Free from black spots from careless mixing of some of the ingredients such as chocolate.
8. Never packed in rusty cans.
9. Different colors never mixed in the same can, nor the ice cream of different batches run into the same cans, because these may have various shades of color and injure the sale of the ice cream.

Remedy: An attractive appearance of the ice cream goes a long way toward selling it. The consumer does not like a rough grained or a partly melted product, but wants the ice cream to remain frozen for a reasonable length of time; and if colors are used, these should be uniform throughout each color.

If fruit is used in the ice cream the color should correspond to that of the natural fruit. Flashy, highly colored ice creams are not so attractive or so popular as the appropriate colors for food products, because flashy colors may suggest some defects or abnormal constituents in the ice cream that are repulsive to the consumer.

In making chocolate ice cream try to avoid the black specks sometimes noticed by failing to mix the chocolate carefully with the cream before freezing it.

Packing cans from which the tin is worn off or which have rusty spots are often responsible for objectionable spots on the ice cream placed in them. Ice cream cans can be easily re-tinned, and can-liners can be used if necessary.

Buttery Ice Cream

Buttery ice cream may be caused by:

1. Over-stirring the mix, which may cause the fat of the cream to churn out.
2. Freezing the mix too slowly.
3. Using a cream that has been partially churned before freezing.
4. Freezing the mix too long a time.
5. Allowing the cream to enter the freezer when it is too warm.
6. Some defect in the construction of the freezer.
7. Warm brine around the freezer.
8. Too soft butterfat in the cream, as is some times the case during the spring of the year when the cows are just going to pasture.
9. Using a mix that has not been homogenized.

Remedy: The brine around the freezer should be cooled nearly to zero, and the cream cooled before it is added to the freezer, and finally homogenizing the cream will prevent this defect to a great extent.

Clinging Flavor in Ice Cream that Resembles Custard or Cooked Flavor

Clinging flavor in ice cream that resembles custard or cooked flavor may be caused by using cream that has been homogenized at 175° F. or higher. This may be prevented by allowing the cream to stand a day or two before it is delivered to the customer.

Fat Rising on the Surface of Ice Cream

Fat rising on the surface of ice cream may be caused by:

1. Failing to freeze the ice cream to the right consistency.
2. Allowing the ice cream to soften after it has been hardened.

The sticky sensation remaining in the mouth which creates a desire to drink large quantities of water after eating some kinds of ice cream is caused by too much gelatine in the ice cream and by the same things that cause a buttery ice cream.

Flat Flavor in Ice Cream

A flat flavor in ice cream may be caused by skimping the amount of flavoring materials used or failing to use sufficient sugar. The flavoring materials should be carefully tested before adding them to the mix and the mix should contain from 10 per cent to 15 per cent sugar at least.

Flavor Defects in Ice Cream

Flavor defects in ice cream may be caused by:

1. The feed of the cows producing the milk from which the cream is skimmed.
2. The materials other than cream used in making the ice cream.
3. Certain flavoring extracts used in excess.
4. Excessive use of condensed milk.
5. Carelessness in caring for milk at the farm.
6. Unsanitary cream cans or dairy utensils.
7. Bacteria from dirty utensils, cheap gelatine, cheap flavoring extracts, cheap fruits.

Remedy: The effect of certain feed flavors, weed flavors, silage, etc., on milk and cream used for ice cream making may be overcome in the same way as advised for preventing

these flavors in the milk and cream from which butter is made, see page 98.

The objectionable flavors in ice cream from materials or ingredients used in making the ice cream may be easily overcome by carefully selecting these materials and using only such as are in a sound, well preserved condition, especially the fruits for flavoring ice cream.

Gluey Flavor in Ice Cream

Gluey flavor in ice cream may be caused by soaking the gelatine in hot water, and by using a poor gelatine. This can be prevented by soaking the gelatine only in slightly warm water and always using a good grade of gelatine.

Graininess or Sandiness in Ice Cream

Graininess or sandiness in ice cream may be caused by:

1. Too rapid freezing of a mix low in solids.
2. Crystalization of the milk sugar in the condensed milk or skim milk powder used for making the mix.
3. The use of a mix that has been previously frozen.
4. Too much swell in the ice cream.
5. Using a high percentage of condensed milk in the mix.
6. Holding ice cream for too long a time before selling it.

Remedy: Since milk sugar will crystalize out of a too concentrated mix, it is advisable to make the mix of such a composition that it does not contain over 6 per cent milk sugar. The possibility of this defect developing may be reduced by carefully regulating the hardening room temperature and also by cutting down the amount of condensed or evaporated milk used in the mix.

The ice cream mix should never be made by the hit and miss method, but by an exact calculation or formula so as to be sure that the ingredients of the mix are added in an exact proportion of the mix.

If the ice cream can be consumed soon after it is made and is not held at too high a temperature before it is sold, this will reduce the possibility of sandiness.

Homogenizing or emulsifying the ice cream mix is one of the most effectual remedies for the defect.

Hard Body in Ice Cream

Hard body in ice cream may be caused by:

1. Freezing the mix too rapidly.
2. Freezing too much.
3. Freezing for too long a time.

Iciness or Ice Crystals in Ice Cream

Iciness or ice crystals in ice cream may be caused by:

1. Insufficient freezing.
2. Re-hardening melted or partially melted ice cream.
3. Lack of stabilizer, such as gelatine or gum tragacannth.
4. Failing to keep the hardening room or ice cream cabinet at a uniformly low temperature.
5. Using a mix which contains an insufficient amount of milk solids not fat, that is, less than 10 per cent.
6. Low speed of the dasher in the ice cream freezer.
7. Packing the ice cream in warm containers.

Remedy: If the mix is low in solids not fat, use sufficient milk powder to give the ice cream a smooth texture, and freeze the mix in not less than 10 minutes.

A Low Overrun in Ice Cream

A low overrun in ice cream may be caused by:

1. Freezing too rapidly.

2. Not freezing the mix sufficiently.
3. Using too much gelatine or sugar in the mix.
4. Failing to age the cream after it has been pasteurized.

Remedy: If either pasteurized milk or cream is used in making the ice cream mix, these should be aged by cooling to a temperature near 40° F. for 12 to 24 hours before making the mix, and if the overrun is too low it may be brought up by adding more condensed milk to the mix so that it contains at least 35 per cent total solids. Further, the mix should enter the freezer at a temperature near 40° F. and the dasher on the freezer run at the required speed.

Homogenizing the ice cream mix has a beneficial effect in getting the right overrun, or in preventing a too low overrun. Further, the mix should fill the freezer at least half full and the freezing period cover from 12 to 30 minutes, but the ice cream should not be cooled below a temperature of 26.5° F. when it is drawn from the freezer. Milk solids not fat and egg albumen increase the overrun, but their use should be restricted and adding an excess of either one avoided.

Lumpy Texture in Ice Cream

Lumpy texture in ice cream may be caused by:

1. Mixing too much air during the freezing process.
2. The separation of water crystals during the freezing process.
3. Lack of a so-called "binder" or too little gelatin.
4. Crystallization of the milk sugar in the ice cream.
5. Too high a per cent of milk solids in the mix.

Remedy: Too much air in the ice cream may be caused by excessive whipping during the freezing process. In such cases the ice cream can be drawn off before it is completely frozen. A ice cream maker may whip down the cream a second time in order to overcome this defect.

When water crystals are formed in the ice cream these show some neglect on the part of the ice cream maker in

taking care of the cream after freezing it. The ice cream may have been left in a warm room too long a time before placing in the hardening room, or the cans into which it is emptied may be too warm when filled. In this case the cream next to the walls of the can will melt, and when placed in the hardening room this cream freezes again and may be responsible for the ice crystals.

By homogenizing the cream the lumpiness is often overcome, especially when skim milk powder is used in making the ice cream mix.

If the mix is placed in the freezer when it is too warm, some of the butter may be churned out in small granules, especially if the brine is not turned on when beating of the cream in the freezer begins.

A lumpy condition in ice cream may also be caused by failing to homogenize the mix before freezing it. In fact, nearly all the defects in either body or texture of ice cream may be overcome or at least largely controlled by using the homogenizer in preparing the mix before freezing.

The Package of Ice Cream

The package of ice cream should be:

1. Neat and attractive.
2. Perfectly clean.
3. Free from finger prints on the surface.

The manufacturer, as well as the seller of ice cream, should thoroughly appreciate the attitude of many of his fastidious buyers and the consumers of his product; a neat, attractive package will go a long way toward satisfying the consumer and making a favorable impression, which leads to recommendations to others.

A Piercing Sweetness in Ice Cream

A piercing sweetness in ice cream may be caused by using too much honey as a flavoring ingredient.

The Richness of Ice Cream

The richness of ice cream may be controlled by:

1. Standardizing to the legal standards of the state or city in which the ice cream is made.
2. Testing the mix before it is frozen.
3. Adding rich cream, 40 per cent fat, when test shows the mix is low in fat.
4. Adding condensed milk when the test shows the mix is high in fat and low in solids.

Remedy: Every mix, as well as the finished ice cream, should be carefully tested in order to find out how close it comes to the legal standard of the locality where the ice cream is consumed.

A sufficient supply of rich cream, condensed milk and other materials should always be kept on hand for use in re-standardizing the product when it is found to be lacking in any particular constituent the law requires ice cream to contain.

The body of ice cream, or its texture, is generally described as firm and mellow when it is right.

Rough and Watery Ice Cream

Rough and watery ice cream may be caused by:

1. Excessively rich cream.
2. Too much butterfat in proportion to the amount of gelatine used.
3. Lack of air spaces in the ice cream, due to slow freezing or freezing for too long a time.

Remedy: The relation between the gelatine and the richness of the cream used, or the fat in the mix, may be easily regulated by noting the effect which certain mixtures have on the final product and then adopting the mixture which seems to give the best results with the proportion used.

If the ice cream is frozen too rapidly, the product will not have sufficient air mixed with it, and this is likely to make the ice cream soggy and heavy.

The length of time used in freezing the mix should be regulated so as to give about 100 per cent overrun, and when this is obtained by running the freezer in such a way that the whipping process during freezing mixes this amount of air with the cream, the final product will be satisfactory in so far as the body of the ice cream is concerned.

Some of the ice cream improvers are beneficial in giving a uniform body to the ice cream.

Rolling Under the Spoon

Ice cream rolling under the spoon may be caused by too much sugar or other substitutes such as glucose, corn sugar, and milk sugar. It may be prevented by reducing the amount of these sweetening ingredients.

Shrinkage in ice cream may be caused by using sugar substitutes to the extent of 20 per cent or more of these substances. They are likely to lower the freezing point of the mix and a high sugar content has a tendency to give a soft cream which will shrink more than a hard cream, or one with the right texture.

Sampling and Testing Ice Cream

It makes no difference whether the ice cream is frozen or melted: a quantity of it is weighed into a cream test bottle in the same way as sweet cream is weighed into a test bottle. About the same amount of clean water as ice cream is added to the test bottle, and the test completed by one of several methods.

Either sulphuric acid alone or a mixture of glacial acetic acid and hydrochloric acid is added to the ice cream by one method, and by another method acetic acid and sulphuric acid are used.

The results obtained are satisfactory, but the choice in acid mixture depends greatly on the party doing the testing. Some get good results by using sulphuric acid alone, others prefer the glacial acetic and hydrochloric acid mixture, while still others prefer the acetic and sulphuric acid mixture. If the latter is used the method of procedure is to weigh about 9 grams of the ice cream into a cream test bottle and add 9 c.c. of water to it. To this mixture of ice cream and

water, add about 5 c.c. of acetic acid, after which 8 c.c. of sulphuric acid (full strength) is added. After mixing these acids with the ice cream in the test bottle it is whirled in the centrifuge and the test completed in the usual way.

If 9 grams of ice cream are taken for the test, the results should be multiplied by two, or in case a definite weight of ice cream is added to the test bottles the fat reading is multiplied by 18 and the product divided by the weight of cream taken for testing. The result gives the per cent of fat in the ice cream.

Soggy or Heavy Ice Cream

Soggy or heavy ice cream may be caused by:

1. Using a mix which contains over 12 per cent of milk solids not fat.
2. Freezing the cream before the air is encorporated.
3. Over-freezing.
4. Using superheated condensed milk, which is likely to give a heavier bodied ice cream than the un-superheated condensed milk.

Remedy: The cream should be aged somewhat before it is mixed with the other constituents of the ice cream mix, and this mix should not contain over 12 per cent milk solids not fat. 10 per cent is about the right amount of this ingredient. The ice cream should not be over-frozen, and sufficient air should be incorporated in the mix during freezing to give it the desired texture.

Sour Cream Flavor in Ice Cream

Sour cream flavor in ice cream may be caused by using cream having more than .2 per cent acidity and also by acid fruits used for flavoring or other purposes in the mix.

The ice cream mix should not have more than .2 per cent acidity when it is frozen, as it is impossible to reduce the high acidity after freezing.

Sticky or Gummy Ice Cream

Sticky or gummy ice cream is caused by using too much gelatine. The amount of gelatine should not be more than .3 to .5 per cent of the mix.

Streaked Color in Ice Cream

Streaked color in ice cream may be caused by:

Adding color to the mix too late. It should be added before the freezing begins.

Tough Ice Cream

Tough ice cream may be caused by:

1. Using too much gelatine.
2. Using materials in the mix that have been much advertised but not tried.

Unevenness in Quality of Ice Cream

Unevenness in quality of ice cream may be due to:

1. Lack of uniformity in flavoring extracts, fruits, and other materials used in the every-day mix.
2. Excessive use of some constituent of the ice cream from day to day.
3. Failure to inspect the ice cream mix before it is frozen.
4. Variation in acidity of the cream used in the mix.

Remedy: A mix that is standard in flavor and other qualities requires careful attention to the quality of each one of the ingredients used in making the mix. The cream added to the mix should not be over .2 per cent acidity, the flavoring extract must be uniform in strength from day to day, and the fruit juices added need special attention to prevent the use of too much highly flavored or unsound fruit.

Defects in the flavor and other qualities of the ingredients of ice cream are easily noticeable in the finished product. An effort is sometimes made to use defective ingredients, thinking that a sufficient amount of good material has been used to overcome these defects. Such a practice is not usually successful, as any defective ingredient added to the mix will usually be noticed by the consumer in the finished product.

In case any one ingredient of the mix may have been added in excess, this may be overcome by making a larger quantity of mix and adding more of the other constituents. Many ice cream makers judge the uniformity in standard of the mix they are using by tasting of it; and while this is not recommended as a general practice, it may be used when in doubt, and any defects noticed may be remedied by taking the necessary steps to overcome such defect.

Uniformity in ice cream is one of the standard qualities that helps to sell this product. Any variation in flavor, hardness, or color of the appropriate shade for the product furnished, is quickly noticed by the consumer.

An ice cream that can be identified day by day and year by year as always the same standard quality in every respect will aid greatly in creating a continued demand for it.

This uniformity can only be obtained by carefully weighing the ingredients used in making the mix and in preparing the mixture in the same uniform way each time then restandardizing the mix after it is once made.

A standard over-run is helpful in contributing to the uniformity of the product sold. This can be obtained by carefully watching and checking the freezing process.

The clean appearance of the workmen, the machinery, the packages, the hardening room, and careful attention to the appearance of all parts of the plant as well as to the transportation packages will aid greatly in increasing the consumption of this valuable food product and avoid any objectionable statements that may be made in regard to it, especially as to its bacterial count. This may easily be kept down to the standard required by the most fastidious person by thorough cleanliness and pasteurization as well as by the use of hot water and steam in cleansing all the machines and utensils used in the manufacture of ice cream.

Watery Texture in Ice Cream

Watery texture in ice cream may be caused by:

1. Failing to freeze the mix a long enough time.
2. A mix lacking in solids.

Weak Body in Ice Cream

Weak body in ice cream may be caused by:

1. Too low a percentage of milk solids not fat.
2. Too much swell in the ice cream.
3. Using a pasteurized cream mix which has not been held cold for a long enough time after pasteurizing it.
4. Adding too much sugar to the ice cream mix; that is, increasing it above 16 per cent.
5. Insufficient freezing.
6. Too rapid freezing.
7. Using cream for the mix that is only a few hours old after separating it.
8. Too low speed of the dasher in the freezer.

Remedy: If the mix used in making ice cream has been pastuerized, it should be immediately cooled to about 40° F. and allowed to stand at near this temperature for 24 to 48 hours after it has been cooled. The mix should not contain more than 12 to 14 per cent sugar and it ought to be frozen in 15 to 20 minutes, getting as high an overrun as is consistent with good quality of ice cream.

Homogenizing the ice cream mix greatly improves the body; and, if condensed milk is used, select the superheated condensed milk rather than the un-superheated.

CHAPTER VI

Dairy Farmer's Questions

Making and Selling Butter from the Farm

Making and selling butter from the farm is likely to be unprofitable for the following reasons:

1. The first cost and the repairing of farm butter-making machinery are somewhat expensive.
2. Making the butter requires careful work and takes considerable time, which may be more profitably used.
3. Finding butter buyers requires more time than expected.
4. Making regular deliveries of butter to customers is tedious and time-consuming.
5. Losses from butter customers who do not pay their bills cut into the profits.
6. The many petty annoyances are not worth the time and trouble required to make and sell farm butter.

By selling milk or cream to a factory the farmer has more time to give to his cows and to study the economical production of milk than is the case when he goes into the business of manufacturing and selling his own butter.

It is true that select customers may be willing to pay five or ten cents above the market price for a supply of butter from one farm, but a simple calculation should be made to see if this is actually profitable.

Suppose a man is making and selling butter to his own customers and he keeps 30 cows. The cream from these cows ought to be churned and the butter made at least every other day. This would require considerable time, for which the farmer should receive some compensation.

Suppose from these thirty cows he gets sufficient milk and cream to make thirty pounds of butter per day, and he sells

this butter to his customers at, we will say, 5 cents per pound above the existing market price of butter. This thirty pounds of butter at 5 cents a pound amounts to $1.50 per day, which is certainly not a good investment of the time and labor required of the farmer when he can sell sweet cream to a cream buyer for the market price per pound of butterfat in the cream.

Making and selling farm butter from 30 cows and collecting the money due for butter is worth much more than $1.50 per day to a busy man when he can earn more than this by devoting his time to weeding out the unprofitable cows and concentrating his attention on raising stock that will produce milk economically.

Butter customers usually want their butter delivered at least twice a week, and this necessitates a good farm refrigerator, which is expensive. The buttermaking machinery and supplies are also a continual expense and in addition to this not many farmers have had the necessary training to become a good butter maker or a successful retail butter merchant.

The profits from keeping cows on the farm are all on the side of selling the milk or the cream to some buyer or factory and devoting the farmer's time and energy to economical milk production from cows that give an abundant flow of milk.

Creamery vs. Cheese Factory

A change from one to the other is not beneficial to the dairy farmer for the following reasons:

1. The market supply of both butter and cheese is usually sufficiently uniform during the year to make little difference in the returns the farmer may receive at either factory when he takes the entire year into account.
2. Increases in prices of either butter or cheese are usually temporary.
3. The cost of manufacturing is about the same at both factories.
4. The cost of making may be reduced by increasing the patronage of either factory.

5. There will always be some patrons at a cheese factory who think it ought to be a creamery, and some creamery patrons who think it should be changed into a cheese factory, but if the change is made from one to the other the patrons of the factory making the change will lose more money than the patrons who do not change.

6. More money is lost than gained by the farmer in changing from one to the other.

In order to calculate the approximate returns to the farmer from the creamery and from the cheese factory, it is necessary to know the price of butter, the price of cheese, the cost of making butter, and the cost of making cheese. This information, together with the test of the milk and the farm price of corn per bushel, may be used for making such a calculation in the following way:

> Assuming the price of butter to be 40c, and the price of cheese 20c; the cost of making butter 4c a pound, and the cost of making cheese 3½c a pound. The test of the milk is 3½ per cent fat, and corn is selling for 80c a bushel.

At the creamery the farmer's cream from 100 lbs. of milk testing 3½ per cent fat will make about 4 lbs. of butter. If the creamery sells this butter at 40c per pound it will receive $1.60 from which we must subtract the cost of making the 4 lbs. of butter at 4c per lb., or 16c, leaving a balance of $1.44, which the farmer receives at the creamery.

To this $1.44 must be added the feeding value of the skim milk and the buttermilk which per 100 pounds, are worth about five times the market quotation on live hogs per pound, or when hogs are selling for 10 cents per pound. 100 pounds of skim milk or buttermilk are worth 50c.

Another way of figuring, also based on pig feeding trials, is to assume that 100 pounds of skim milk or buttermilk are worth as much as one-half a bushel of corn and when corn is quoted at 80c per bushel, the skim milk or buttermilk are worth at least 40 cents per hundred pounds for feeding calves, pigs, and chickens.

In skimming 100 pounds of milk, however, the farmer only gets, we will say, 80 lbs. of skim milk, which at 40 cents per

hundred, is worth 32c. This 32c must be added to the $1.44, making $1.76, the net returns to the farmer per 100 lbs. of milk, when cream is sold to a creamery.

At a cheese factory the 100 lbs. of milk testing 3½ per cent fat may be made into about 9½ lbs. of cheese, and if the market price of cheese is 20c this will amount to $1.90.

The cost of making the 9½ lbs. of cheese at 3½c a pound is 33c. Subtracting this from $1.90 leaves $1.57. To this must be added the feeding value of the whey returned to the farm which is one-half that of skim milk, or, in this case, 16c, and adding this to $1.57 gives a net return to the farmer of $1.73 for his 100 lbs. of milk testing 3½ per cent fat at the cheese factory.

A similar calculation can be made at any time in any locality by substituting different prices of butter, cheese, corn, hogs, and cost of making the butter or cheese.

The best way for a farmer to become prosperous in patronizing a creamery or a cheese factory is to devote his attention to the economical production of milk on his farm.

First find out how much milk each one of his cows is giving, and then keep in his herd only such cows as can convert feed into milk enough to more than pay for the feed and for the feeder's labor.

As soon as the farmer develops a herd of cows of this kind and devotes his time to the economical raising of feed and of feeding the cows, he will find that farming is a satisfactory business and the creamery or the cheese factory will pay him profitable prices.

A cheese factory can be started in a locality where it will receive the milk from at least three hundred cows within three miles or less of the factory, but a prosperous creamery ought to receive the cream from five hundred cows, within a territory of ten miles from the factory, while a milk condensery needs the milk of one thousand cows or more.

The machinery and equipment for a small cheese factory may cost $3,000, for a creamery $5,000, and for the milk condensery $50,000 or more. Plans for a building and a list of the equipment needed for any one or all of these factories may be obtained from dealers in such supplies.

As a rule the farmer receives about the same returns from either a creamery or a cheese factory although there may be a

temporary advance in price at either one and some patrons will want to make a change at that time. The market supply of both butter and cheese is usually sufficiently uniform during the year to make very little difference in the returns the farmer will receive for his milk or cream at either factory.

The Separation of Cream From Milk

A higher price is paid for sweet cream than for almost any other dairy product. This is one reason at least why so much attention has been given to the perfecting of some method that will take all the cream out of milk in the most economical way.

Three methods of separating cream from milk have been used in the past:

1. **The gravity method,** that is, setting milk in pans or cans for a number of hours, and then skimming off the cream with a hand skimmer or drawing off the skim milk under the cream.

2. **The water dilution method,** by which either cold or warm water is poured into milk fresh from the cow and by so doing diluting the serum of the milk and causing a certain amount of the cream to rise quickly to the surface of the milk and water mixture.

3. **The separation of cream from milk by a centrifugal cream separator.**

Up to the present time no method has been devised that will recover all the cream from milk. Losses occur during each handling of the milk, first from waste of milk that sticks to the pails, cans or machine, and second, from fat or cream left in the skim milk. The amount of fat lost in these two ways may be very small or it may be a large percentage of the fat in the whole milk, depending on the efficiency of the method and the carefulness of the persons doing the work.

Cream separates from milk because the fat is lighter than the milk serum. This difference in weight may be represented by the figures .9, which is the specific gravity of milk fat and 1.04 the specific gravity of milk serum or skim milk.

The term "specific gravity" means that if a certain quantity or measure of water at a given temperature weighs 1.00, then the same quantity of milk serum, or skim milk weighs 1.04 and the same quantity of butterfat weighs .9. This difference in weight or in specific gravity between the milk serum and the fat is the cause of cream separation.

If the fat in milk were free to move in the serum of the milk there would be a complete separation of the cream when milk is allowed to stand quietly for a number of hours. This, however, is not the case, because the curd or casein and the other substances in the milk serum, retard the movement of the fat in the more or less viscous serum.

There are two factors that have an influence on the separation of the cream from normal milk, first, the amount and the condition of the substances dissolved in the milk serum, and second, the size and the number of the fat globules which vary in different samples of normal milk.

Gravity Methods of Cream Raising

The conditions favorable for getting good results by the gravity methods of separating cream from milk are:

1. Setting the milk immediately after milking.
2. Keeping the milk at a temperature of 50° F. or lower.
3. Skimming the cream as near to the skim milk as is consistent with getting a rich enough cream.

Some experiments made by setting milk in cans and placing these in cold water show that the temperature at which the milk is held has a great effect on the efficiency of the cream raising. When milk was set at a temperature of 45° F. the skim milk tested .2 per cent fat; at 48° F. it tested .3 per cent fat; at 50° F. it tested .5 per cent fat, and at 60° F. it tested .9 per cent fat. These results show that milk set at the lowest temperature was the most exhaustively creamed, and this has been found to be universally true, principally because a cold temperature keeps the milk sweet and the cream can rise through the milk serum before it sours and becomes thick or curdled.

Cream Raising by Dilution with Water

Separating cream from milk by adding water to it is a very old idea and now out of date, but every few years some agent is found traveling around the country with a cheap combination of tinware, tubes, etc., trying to induce the farmers to buy this "valuable" invention. It is sometimes called a separator, although it is only a tin can with a funnel cover and possibly a tin tube on one side of it and a faucet at the bottom.

The common directions for using this method of separating the cream from milk are, to take the tin can separator to the cow stable; pour the warm milk from each cow into the can right after milking, then add to it an equal amount of water, and after waiting a few minutes, a certain amount of the cream will be seen on the surface of the mixed milk and water. A very thin skim milk is then drawn off through the faucet at the bottom of the can; but the farmer should not forget that he has made the skim milk thin by watering it.

These "hydraulic" or "ventilated" cream separators, as they are sometimes called, are all operated on practically the same plan. Any tin can with a faucet at the bottom will answer the purpose for which these, much decorated and brilliantly painted wonders are sometimes sold at large prices. Dairymen should know that they are not so efficient as the methods ordinarily used for skimming milk at the farm.

Average Results from Skimming Milk by Gravity Methods

The following summary gives the temperature, also the test of the skim milk and the cream that may be expected when these gravity methods of cream separation are used under average conditions.

Method	Temp. of Milk F.	Per Cent of Fat in	
		Skim Milk	Cream
Shallow setting	60– 90	.1– .5	10–35
Deep setting	40– 50	.2– .5	15–20
Dilution, aquatic	40–140	1.0–1.5	10–12

Cream Separation by Centrifugal force

A great advance over all other methods of separating cream from milk was made by the invention of the centrifugal cream separator. There is a great difference between the action of gravity and of centrifugal force, not only on the application of these two forces to the separation of cream from milk, but on their action to separate any two liquids which may be mechanically mixed and have a different specific gravity. This may be illustrated by comparing the weight or the gravity of a body with the pull on a string to which a weight may be attached and whirled around one's head at a high speed. The pull on the string is influenced, first by the length of the string, second, by the speed with which the body is whirled around, and third by any differences in the weight of the bodies attached to the end of the string. This explains somewhat the action of centrifugal force on milk in a cream separator. The cream is separated from the skim milk because the fat is lighter than the serum and when whirled around at a high speed, the fat or cream collects at the center and the skim milk at the circumference of the separator bowl.

Advantages of a Centrifugal Cream Separator Over Gravity Skimming

The same conditions that affect the cream rising by gravity, influence centrifugal cream separation, but to a less degree.

First the friction of small fat globules is greater than large ones, as they have more surface for a given amount of fat. Second, the condition of the fibrium in milk makes cream separation easier directly after milking than after standing some hours; and third, the depth of milk in the separator bowl or the greater the distance the milk must travel before leaving the bowl, the more efficient is the skimming.

A comparison of the centrifugal and gravity methods shows:

1. That the centrifugal separator skims milk satisfactorily at a greater range in temperature, say anywhere from 80 to 120 degrees F.

2. There is less exposure of the milk to air, dirt and bacteria when skimmed by a separator.
3. There is greater certainty of skimming nearly all the fat from the milk, as a machine is not subject to all the influences which man cannot regulate such as temperature, weather, lack of ice, transportation, etc., which affects gravity skimming.
4. The separator cleans dirt and slime from the milk during the skimming.
5. A better quality of cream is obtained where milk is skimmed immediately after milking, and the cream is perfectly sweet when separated.
6. The richness of the cream may be easily regulated.
7. The skim milk is in the best possible condition for feeding purposes when separated right after milking.
8. The cream is nearly all skimmed from the milk, the skimmed milk containing only a trace of fat when all the conditions of skimming are right.

Skimming efficiency

The skimming efficiency of any method of cream separation is sometimes expressed in percentage which the cream fat is of the whole milk fat. If 100 pounds of milk containing 4 per cent fat are so skimmed that 85 pounds of skim milk testing .2 per cent fat is obtained from it, then this .17 pounds of fat (or 85 x .2 per cent = .17) subtracted from the 4.0 pounds fat in the whole milk, leaves 3.83 pounds of fat in the cream. The per cent which the fat recovered in the cream is of the fat in the whole milk represents the skimming efficiency of the method, or expressed in form of a proportion, 4 : 3.83 :: 100 : X = 95.75 per cent.

This figure will be influenced both by the richness of the milk and the amount of skim milk as well as by the test of the skim milk. If the milk tested 3.0 per cent. fat, and .17 pounds fat was left in the skim milk as before, the skimming efficiency is 94.35 per cent or 3 minus .17 = 2.83, and 3 : 2.83 :: 100 : X = 94.35.

If 80 instead of 85 pounds of skim milk is taken and this tests .2 per cent fat, the skimming efficiency of milk testing 4.0 per cent fat is 80 x .2 per cent or .16 pounds, and 4 — .16 = 3.84 pounds, which is the fat recovered in the cream and using the same proportion, 4. : 3.84 :: 100 : X = 95.78 per cent, the skimming efficiency in this case.

Selecting a Cream Separator

A few of the points to be considered as important in a cream separator are:

1. The simplicity of the bowl and of the machine in general.
2. Method of attaching power to the bowl.
3. The construction of the bowl, its diameter, weight and the amount of time required to clean the bearings of the working parts.
4. The cream regulating device.
5. The capacity or amount of milk skimmed per hour.
6. Time required to put together, take apart and clean the bowl.
7. Protection of the operator from moving parts.
8. Convenience for oiling and amount of oil needed.
9. Smoothness of the cream.
10. Power required to operate the machine.
11. Durability.
12. Convenience of obtaining repairs.
13. Test of the skim milk.

Some separators have more of these points satisfactory than others, and in making a selection one must decide to what extent these requirements are satisfied in one machine more than in another. When the price is the same for equally good skimming, and for the amount of milk skimmed per

hour, the advantages of each separator in construction should be considered.

A Method of Testing a Cream Separator

The capacity and the skimming efficiency of a separator may be recorded with the following observations:

1. Date_____
2. Name of separator_____
3. No. of separator bowl_____
4. Speed of bowl, r. p. m._____
5. Temperature of milk_____
6. Weight collected in_____minutes.
7. Cream_____lbs. Skim milk_____lbs.
8. Skimming per hour_____lbs.
9. Proportion of cream from milk_____
10. Test of skim milk_____
11. Test of cream*_____
12. Test of the whole milk_____

A series of records like the above may be made when the separator is running below speed as well as at normal speed. This will show the effect of variations in speed on the skimming.

Other tests made when milk is skimmed at different temperatures and when more or less than the advertised amount of milk is being skimmed per hour, will show how these variations in capacity, in speed and in temperature will affect the skimming.

When the separator is running under normal conditions the cream may be collected in pail No. 1 and the skim milk in pail No. 2 by holding these under the respective spouts of the separator for a certain number of seconds. If one pound of

*This may be calculated if necessary.

cream and nine pounds of skim milk are caught from the separator in exactly one-half minute of skimming, the total weight of milk skimmed in one minute is 20 pounds, and in one hour it is 20 x 60, or 1200 pounds. The capacity of the separator then is 1200 pounds per hour according to this observation. The proportion of cream from milk is one pound of cream from each 10 pounds of milk.

Calculating the Test of Cream

The test of the cream skimmed by a separator may be calculated from the weights and tests of the milk and the skim milk collected.

If the whole milk tested 4.0 per cent fat and the skim milk one-tenth of one per cent fat, the test of the cream may be found as follows: the record shows that in each 100 pounds of milk skimmed there is obtained 90 pounds skim milk and 10 pounds cream. They also show that in this 100 pounds of milk there are four pounds fat. If the fat separated in the skim milk is subtracted from the whole milk fat, that which is left must be the cream fat. The weight of this fat is obtained by multiplying the 90 pounds skim milk by its test, .1 per cent, (90 x .001) which equals .09 pound fat, then subtracting this from the 4 pounds of fat in the whole milk leaves 3.91 pounds fat in the 10 pounds of cream and the test, or per cent, of fat this represents is shown by the proportion 3.91: 10 :: X : 100 in which X equals 39.1 per cent fat, or the calculated test of the cream.

Steady Running of the Separator

If the separator runs roughly and trembles when under full speed, an efficient skimming may be interfered with. The cause of the vibration should be located at once. An uneven or unsteady motion which makes the separator pans or frame vibrate may becaused by:

1. The separator frame or bowl is not level.
2. The frame is not securely fastened down.
3. The bowl is out of balance.

4. The bowl is too high, does not run freely.
5. The bowl is not put together properly.
6. The bearings are too tight.
7. The milk enters before bowl is up to full speed.
8. The oil is not good, or bearings are gummed.
9. Defective gearing or a too tight belt.
10. Worn or dirty bearings.
11. The bowl is running backward. This is dangerous, as the cover may be thrown off when the bowl turns in the wrong direction.
12. The speed is too high.
13. The cover is not screwed down to the mark.

Running a high-speed separator bowl when it trembles perceptibly at full speed is not safe. An effort to remedy the difficulty should be made at once, and if unsuccessful in overcoming this by such means as are available, the bowl should be sent to the manufacturers for repairs. When a separator bowl needs repairing it should not be sent away until after a "loaning bowl" is received from the repair shop. "Loaning bowls" are usually kept on hand at the factory and can be put into the separator frame and used until the one needing rebalancing or other repairs is returned.

The Farm Cream Separator Efficiency

The farm cream separator efficiency is influenced by:

1. The cleaning of the separator bowl.
2. The speed at which the bowl revolves.
3. The amount of milk skimmed per hour.
4. The temperature of the milk during skimming.
5. The mechanical condition of the machine.

The question is sometimes asked: "Which is the best farm cream separator?" The following answer has been suggested:

"The best cream separator is the one that skims the most milk at the lowest temperature with the least power, and is most durable and most easily cleaned."

Some separators are good skimmers when all conditions are right, and these conditions must be watched in order to get the best results. Other separators, however, are less influenced by variations in the milk and in the running of the machine.

The following data show the effect which a few of the skimming conditions at the farm may have on the results obtained when a farm cream separator is used for an entire year for skimming the milk of one cow, assuming that the cow gave 9000 lbs. of milk in a year, that 85 per cent of this was skim milk and that the fat in the milk was worth 60c per pound:

Value of Losses in Skim Milk from Milk of One Cow for One Year

assuming 9,000 lbs. milk; 85% skim milk; 60c lb. for fat.

	Skim Milk Fat %	Fat Losses Pounds	Value of Fat Lost
Balanced bowl	.03	2.3	$1.38
Unbalanced bowl	.17	13.0	7.80
Normal speed	.029	2.21	1.32
10 Turns low	.12	9.18	5.50
20 Turns low	.21	16.06	9.60
Washed each time used	.038	2.98	1.80
Washed once daily	.10	7.45	4.50
Too much milk	.14	11.09	6.65
Normal amount milk	.028	2.14	1.26
Small amount milk	.027	2.06	1.20
Temperature of milk—			
90° Fahr.	.022	1.68	1.00
75° Fahr.	.051	3.90	2.40
60° Fahr.	.120	9.18	5.50

These Figures show the effect on the skimming of milk by a separator, of an unbalanced bowl as compared with a bal-

anced bowl, of a variation in the speed of the bowl during the time the separator is skimming milk, and further, of a failure to wash the cream separator bowl each time after it is used.

Points to be Observed in Running a Cream Separator

1. Read and preserve the manufacturer's book of instructions.
2. Carefully clean all the parts of the separator bowl before using it.
3. Fasten the separator frame securely to its foundation or floor.
4. Place a spirit level on the separator bowl after it is in place in the frame.
5. See that the separator oil runs freely before starting the machine.
6. Never drop the bowl suddenly into its bearings in the separator frame.
7. Bring the separator bowl up to full speed slowly.
8. Maintain a uniform speed of the bowl while skimming milk.
9. When through skimming, flush the bowl with water or skim milk.
10. Clean the separator bowl before the milk sours in it.
11. Open the faucet in the milk supply can wide open when the bowl is up to speed.
12. Inspect bearings and shut off oil supply of the machine after each skimming.

Comments: A new cream separator bowl is often covered with a coating of grease to keep it from rusting. This may be cleaned by first wiping off the grease with paper and then washing it with hot water containing a little washing powder.

It is not necessary to remove and clean the bearings of a new separator bowl, but they should be examined to see if they are clean and bright with no grit or dirt left in them.

The smoothness with which the separator runs and the efficiency of the skimming done by it are both influenced by the care and accuracy with which the separator is placed in position for daily use. The foundation needs to be firm, but not necessarily made of concrete. The separator frame ought to be raised somewhat above the foundation in order to permit cleaning and to prevent milk or dirt from accumulating under it. Some separator frames are placed on rubber cushions enclosed in tin cases, one at each corner.

The lag screws which hold down the corners of the separator frame may be firmly fastened into a stone or concrete foundation by using just enough strips of leather to fill the holes in the cement and make the screws fit tightly. It is better to fasten the lag screws into the foundation this way than to pour melted lead or cement around the screws because these may need losening or tightening to adjust some corner of the separator frame.

Cleaning the Separator after Separating Milk

When through skimming milk, warm water or skim milk should be poured into the milk supply can to flush out the cream in the bowl before there is much reduction in its speed. As soon as the bowl has stopped, both the tin cover, the milk supply can and the faucet are taken off and usually washed in a sink with clean water. After washing they are scalded and placed where they will dry and not rust until used again.

To clean, the cream separator bowl it may be taken out of the frame and placed in a sink or pan of clean, warm water, where the various parts are washed; finally rinsing them with scalding water or steam, making the metal so hot that it will dry without wiping with a towel or cloth. The parts of the bowl may them be kept in a clean place until needed for the next skimming.

The slime that collects in a separator bowl may often be removed in one large piece and burned. It should not be left in the sink or thrown into the drain as it easily clogs these. If the separator bowl has small tubes or openings in it through which the milk passes while skimming, these should all be cleaned by passing a small wire brush through them. This

is very important as small pieces of curd or slime left in any of these tubes will interfere with the skimming.

The Capacity of a Cream Separator

The capacity of the cream separator, or the amount of milk skimmed per hour is determined by the manufacturer. If too much milk is forced through the bowl, the skimming will not be satisfactory as under such conditions milk does not remain long enough in the bowl to receive the full effect of the centrifugal force and some of the cream is left in the skim milk.

Each separator is designed to skim a certain amount of milk per hour and remove all the cream except a trace of fat which is left in the skim milk. The amount of milk skimmed clean indicates the capacity of the separator. This may be be increased somewhat by heating the milk to a higher temperature, but as a rule the capacity advertised by the manufacturer is understood to be the amount of milk that will be skimmed efficiently at a temperature of about 85° F.

Strain on Separator Bowl

If the weight of a certain volume of milk serum is 1.04 lbs., and that of an equal volume of butter fat is .90 lb.,* the difference between the weights of these two volumes is .14 lbs., and the effect which centrifugal force may have to separate the fat from the serum can be calculated by determining the pull which is exerted on a weight of .14 lbs. when revolved at any given speed in a circle of a given diameter.

If the weight .14 lbs. is hung from one end of a spring balance one foot long, and this is revolved about the other end as a center at the speed of 100 revolutions per minute, the indicator on the balance will show that the weight is pulling .48 lbs. Increasing the speed to 200 revolutions makes the pull 1.92 lbs. At a speed of 1000 it is 48 lbs., and at 5000 revolutions per minute the pull of this .14 pound weight on the balance is 1200 lbs. This shows the difference between gravity and centrifugal force to be as .14 is to 1200 when

*These numbers are taken because they represent the specific gravity of milk serum and of butter fat respectively.

milk is revolved at a speed of 5000 revolutions per minute in a circle having a radius of one foot.

Besides showing the difference between the force of gravity and centrifugal force these figures give some idea of the tremendous strain there is exerted on separator bowls run at a high speed. It should be noticed in the figures given that the pull on the balance does not increase directly in proportion to the increase of the speed or the velocity, but to its square. Doubling the speed or velocity quadruples the centrifugal force.

These brief statements show that the strain on the walls of a separator bowl is influenced by three things, the weight of the material revolved, the diameter of the bowl, and its velocity. The smaller the bowls, the higher the speed at which they may safely be run.

Length of Time Milk Remains in the Separator Bowl when Skimming

This may be determined by:

1. Weighing the pounds of milk the bowl will hold when put together for skimming.
2. The speed of the bowl.
3. The amount of milk skimmed per hour.

Suppose a separator bowl holds ten pounds of milk when filled and the separator is designed to skim 3,000 lbs. of milk per hour when running at a speed of 6,000 revolutions per minute. This means that the separator is skimming 50 pounds of milk per minute and if the bowl holds 10 pounds of milk, then the milk must remain in the bowl one-fifth of a minute, or 12 seconds, during the skimming process, and again, if a separator skims a thousand pounds of milk per hour and the bowl only holds 5 pounds of milk, this means that the separator is skimming 16.6 pounds of milk per minute, and since there are 60 seconds in a minute, dividing 60 by 16.6 gives 3.6 seconds as the time it takes to skim one pound of milk. Now, if the bowl holds 5 pounds, the milk must remain in the separator bowl 5 times 3.6 seconds, or 18 seconds when skimming at the rate of 1,000 pounds per hour and the bowl holds 5 pounds of milk.

The longer the milk is held in the bowl the better the skimming. A calculation of this kind can be made to determine how long a time the milk remains in any separator bowl when it is skimming milk, provided the rate at which the milk is flowing through the bowl and the number of pounds of milk the bowl will hold are known.

Effect of Temperature of Milk on Test of Skim Milk

It is very important in skimming milk with a centrifugal cream separator that a uniform temperature be maintained in the milk during the entire time of skimming. The skimming temperature usually recommended is 85° F. Some separators will skim milk fairly well when it has a temperature of 75° F. and nearly all of them skim well at a temperature of 90° F.; but 85° F. is the temperature usually recommended.

If the milk is too cold there will be a loss not only of fat in the skim milk, but a change will be noticed also in the richness of the cream. The following figures illustrate these points:

Temperature of Milk	Cream Fat Per Cent	Skim milk Fat Per Cent
85° F.	27.3	.022
75° F.	28.5	.051
60° F.	36.7	.120

These are average figures and some variation may be expected from them but they illustrate the way in which the temperature of the milk skimmed changes the test of both the skim milk and the cream.

Rich Cream More Profitable than Thin Cream

The benefits a farmer will receive from skimming a rich cream are:

1. More skimmed milk is retained at the farm.
2. There is less cream to cool.
3. Fewer cans are needed for transporting the cream.

4. The cost of transportation is less.

500 lbs. of thin cream testing 20 per cent fat contains just as much butter fat as 250 lbs. of rich cream testing 40 per cent fat.

Suppose the price per pound of fat is 40 cents, then a farmer will receive $40 for his 500 lbs. of 20 per cent cream, and the same money for his 250 lbs. of 40 per cent cream. The 500 lbs. of thin cream will fill 6 cans and the 250 lbs. of rich cream will fill 3 cans. The farmer also loses 150 lbs. of skim milk by selling the thin cream, which he could have saved for feed on the farm if he had sold the rich cream.

The farmer saves, therefore, by shipping the rich cream instead of the thin cream, 250 lbs. of skim milk, 3, 10-gal. cans, and the transportation charges on 3 cans.

The benefits of a rich cream to a cream buyer are:

1. Less vat capacity is need for storing and ripening the cream.
2. Fuel is saved in heating and ice in cooling the smaller quantity of cream.
3. Rich cream can be churned at a lower temperature, thus improving the texture of the butter, if butter is made of the cream.
4. The losses of butter in the buttermilk are less.
5. The buttermaker can use more starter and in this way have better control of the flavor of his butter.
6. The cream can be pasteurized without excessive losses in churning.

The Thickness of Sweet Cream

The thickness of sweet cream is influenced by:

1. The per cent of fat in the cream.
2. The per cent of solids not fat in the serum of the cream.
3. The condition of the casein in the cream.

4. The number, the size, and the grouping of the fat globules.

The heating or pasteurizing of either milk or cream has a marked effect on the cream rising on sweet milk and on the thickness of sweet cream. If milk is heated to 145° F., then cooled and bottled, cream will rise in the neck of the bottle in about the same way it rises on raw or unheated milk, but when milk is heated to a temperature above 145° F., especially if it is held at a temperature of 150° to 170° F. for a few minutes only, very little cream will rise on such milk. This effect of higher temperature on milk and cream has a tendency to lead the consumer who buys the bottled milk or cream to think, in the one case that he is buying skimmed milk because he cannot see any cream in the neck of the bottle and in the second case that pasteurized sweet cream when cooled and bottled is not cream because it does not have the thick appearance of cream when poured into coffee.

This change in the viscosity, or thickness, of cream by heating, has been found to be due to the spreading out or the even distribution of the fat globules in the milk and cream. By studying this phenomenon it has been found that any substance that will collect the fat globules into groups after pasteurization will restore the normal viscosity or thickness to cream. This is accomplished at the present time by controlling the temperature to which the milk or cream is heated during the pasteurizing process. If it is not heated above 145° F. for 20 minutes and then cooled to a temperature near 40° F. and held at this temperature for 24 to 48 hours, the viscosity or thickness which has been destroyed by the heating process seems to return and the milk and cream regains the condition it was in before heating, that is, the cream will rise in the neck of the bottle of pasteurized milk and sweet cream will have its normal thickness if held at a temperature near 40° F. for a long enough period after the heating process.

Viscogen is a substance suggested some years ago for restoring the normal viscosity to pasteurized sweet cream. It is made as follows:

Dissolve two and a half parts of cane sugar in five parts of water, or, if a large quantity is wanted, dissolve 25 lbs. of sugar in 50 pounds of water. This is then poured into a milk-of-lime mixture, made by slacking one part of quicklime in

three parts of water, or if we wish to make the amount necessary to add to the sugar solution suggested above, slake 10 pounds of quicklime in 30 pounds of water. The slaked lime is poured through a wire strainer to take out the coarse lumps and then the sugar solution is added to it.

The mixture is stirred occasionally for two hours or more, then the lime allowed to settle to the bottom of the can. The liquid above the lime is a clear, straw-colored syrup which has a strongly alkaline reaction. This liquid is viscogen and it may be poured into glass bottles or jugs for future use.

The amount of viscogen usually added to sweet pasteurized cream will not vary much from 2 cc. of viscogen to one pound of sweet cream. Since viscogen is made of lime and sugar, and normal sweet milk contains both these substances, it is not considered an adulterant, but it has a tendency to collect the fat globules into groups and give sweet cream the same thick appearance it had before the cream was heated in the pasteurizing process.

Varying Cream Tests

A farmer writes as follows:

"I am separating my milk and selling cream. The cream is gathered once a week, and I want to know if it is possible for my cream to test 30 one week and 21 the following week with the same cows milking and eating the same amount of feed, also the same person running the separator and no changes made in the cream screw of the separator?

"One more question: A man has two herds of cows. One herd is Guernsey and the other is Holstein. He keeps the milk separate and the cream of each herd is handled separately. He runs it all through the same separator with the same person turning the separator. Is it possible for the Guernsey cream to test 10 points more than the Holstein cream? The tester at the creamery tells me this is occurring every day.

"My object is to find out if they are right with me or not. If it does not seem possible to you that my cream should vary 9 points from one week to another, would you kindly write me a good strong letter that I can shake under their noses. I am a new settler in this part of the country and it seems we must fight to get what is due us."

Reply:

It is natural for a man running a cream separator on the farm twice daily to expect the cream from his separator to test the same per cent of fat each day. Careful observations have shown, however, that a number of things have an effect on the richness of the cream, even though the milk is run through the same separator every day and there is very little difference in the amount of milk skimmed each time.

The separation of cream from milk is a comparatively simple operation, but the separator is a piece of machinery that responds to variations in operation more easily than the person operating the machine always realizes.

For instance, if, for any reason the speed of the separator bowl drops below the speed recommended by its manufacturer, this will immediately lower the test of the cream.

An experiment made on this point has shown that when a separator was run at *normal* speed, the cream tested 35 per cent and when it dropped *below normal speed* it tested only 30 per cent fat. This difference in the test of the cream can be easily explained by one who understands the theory of cream separation by centrifugal force.

Another thing that has an effect on the test of the cream is the *temperature of the milk while skimming.* Experiments have shown that milk run through a separator at 90° F. gave cream testing 30 per cent fat, and when more of this milk was run through the separator at a temperature of 70° F. the test of the cream was 36 per cent fat.

A third cause of variation in the richness of cream is *a change in the richness of the milk* skimmed by a separator.

One of the many experiments made on this point showed that when milk testing 3 per cent fat was skimmed, the cream tested 20 per cent fat, and when milk testing 4.5 per cent fat was skimmed by the same separator, the cream tested 32.5 per cent fat.

A fourth important point is the practice of using a *certain amount of water or of skim milk to rinse out the separator bowl at the end of the run.* An experiment showed that the cream from a separator tested 37.5 per cent fat when no water or skim milk was used to rinse out the bowl, but it tested 35 per cent fat when sufficient skim milk or water was poured into the bowl at the end of the run to rinse out all the cream.

You will see, therefore, that a cream separator must be given uniform treatment, because it is a machine and operates according to certain mechanical rules. It will give cream of the same richness every time, provided all the different points which influence the richness of the cream are controlled at each skimming. A change in any one of the points will have some effect upon the richness of the cream which the machine delivers.

As a rule when the same number of pounds of cream are obtained from a given weight of milk the test of the cream may be calculated from these weights provided the test of the milk is known.

Cream of uniform richness may be obtained from a farm separator if the operator will watch the temperature of the milk, the speed of the bowl, the richness of the milk skimmed and the amount of skim milk used for flushing out the bowl at the end of the run. He should also watch the weight of cream obtained from a given weight of milk. If this is done, there will be much less dissatisfaction among cream sellers with the tests they are given by the cream buyers.

The Weight of a Gallon of Milk or of Cream

The weight of a gallon of milk or of cream will be influenced by:

1. The richness of the milk or the cream.
2. The amount of air in the milk or cream.

There is no scale in use by buyers of milk or cream that is sensitive enough to distinguish between the weight of a gallon of milk testing 3.8 per cent fat and the weight of a gallon of milk testing 5 per cent fat, but it is possible to distinguish between the weight of a gallon of water and a gallon of milk, or between the weight of a gallon of milk and a gallon of rich cream.

A gallon of milk weighs more than a gallon of water, but a gallon of cream testing 35 per cent or more will weigh less than a gallon of water.

The weight of a gallon of water is 8.3389 pounds and the weight of a gallon of milk or cream of any test may be obtained by multiplying the specific gravity of such milk or

cream by 8.3389. It will be necessary, therefore, to find the specific gravity of milk and cream of different richness to get a figure that shows the weight of a gallon in each case.

The specific gravity is influenced by the per cent of fat, and by the amount of air in each lot of milk and cream.

About the only way of making a table of standard gallon weights of milk and cream of different richness is to calculate the specific gravity of each lot of milk when these contain no gas or no air. Such calculations have been made and the following are a few of the figures obtained.

Per cent fat in cream	Specific Gravity of cream	Weight of one gal. (pounds)
0	1.036	8.6391
10	1.0243	8.5417
15	1.0186	8.4938
20	1.0129	8.4465
25	1.0073	8.3997
30	1.0017	8.3534
35	0.9963	8.3076
40	0.9908	8.2624
45	0.9854	8.2176
50	0.9801	8.1733

These figures show that the difference between the weight of a gallon of skim milk, 8.6391, and the weight of a gallon of milk testing 10 per cent fat, 8.5417, is only .0974 lb. which is so small a figure that the scales commonly in use for weighing milk could not detect it. The weights here given may be used for calculating the weight of a gallon testing between these figures and all the figures represent cream containing no air.

Mixing Cream and Milk or Skim milk to Make Milk or Cream of a Definite Test

Many suggestions have been made for calculating the pounds of cream and of skim milk or milk that should be mixed to get either a milk or a cream of a certain test.

For standardizing milk or cream it is necessary to know:

1. The weight of a gallon of milk
2. The test of the cream to be used.

3. The test of the milk to be used.

4. The test of the milk or cream wanted.

5. The amount or pounds of milk or cream wanted.

Suppose an eight-gallon can of milk testing 3.4 per cent fat is wanted, and we have skim milk and 18 per cent cream to mix for this purpose.

We first assume that the average weight of a gallon of milk is 8.6 lbs. Then the weight of this 8-gallon can of milk will be, 8 multiplied by 8.6, which is 68.8 lbs. This shows that we want 68.8 lbs. of milk that will test 3.4 per cent fat, and it must be made by mixing cream testing 18 per cent fat with skim milk having no fat test.

Our first calculation is to find out how many pounds of fat there will be in the 8 gallon can of milk testing 3.4 per cent fat. This is done by multiplying 3.4 per cent by 68.8 lbs., which gives 2.34 lbs. of fat.

The next step is to find out how many pounds of 18 per cent cream we must use to get 2.34 lbs. of fat. This is done by dividing 2.34 by 18, which gives 13 lbs.

Therefore, if we add 13 lbs. of cream testing 18 per cent fat to the 8 gallon can and fill it up with skim milk, we will have an 8 gallon can of milk testing 3.4 per cent fat.

The accuracy of the calculation may be proved by multiplying 13 lbs. of cream by 18 per cent and we get 2.34 lbs. fat, which is the figure obtained by multiplying the 8 gal. can of milk by 3.4, the test of the milk.

Cream or milk of any test may be obtained by using other figures with the same method of calculation.

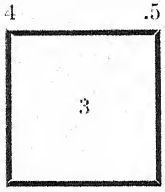
Many other ways have been suggested for finding the figures necessary to determine how many pounds of milk and cream of a given richness must be taken in order to get a mixture of a certain per cent fat.

Tables of figures have been published and short formulas given for making such calculations but one of the most common methods of calculation recommended is the following:

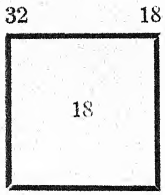
Place at the left hand corners of a square the test of the two kinds of milk or cream that will be used for making the standard product. In the center of the square place the test of the milk or cream wanted, then subtract diagonally, plac-

ing at the right hand corners of the square the differences between the figure in the center of the square and the figures thus obtained. These latter figures at the right hand corners represent the proportions in which the milk and cream should be mixed.

Standardizing milk. If milk testing 3.0 per cent fat is wanted and two lots of milk, one testing 2.5 per cent and the other 4 per cent fat are available, the proportions in which these two should be mixed may be found as follows. See directions given above.

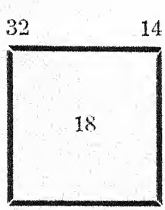


This shows that by mixing .5 parts 4. per cent milk with 1.0 parts 2.5 per cent milk, the mixture will test 3. per cent fat or 1 part 4 per cent milk added to 2 parts 2.5 per cent milk will make 3 parts 3 per cent milk, and if 100 lbs. of milk testing 3 per cent fat are wanted then 5/15 or 1/3 of 100 = 33 lbs. milk testing 4 per cent fat should be mixed with 10/15 or 2/3 of 100 = 66 lbs. milk testing 2.5 per cent fat.



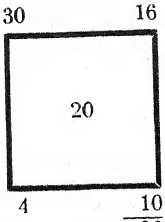
Standardizing cream. How much skim milk is needed to reduce cream testing 32 per cent fat to cream testing 18 per cent fat.

This shows that by adding 14 lbs. skim milk to 18 lbs. cream testing 32 per cent there will be obtained 32 lbs. cream testing 18 per cent fat.

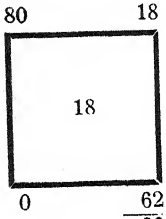


Substituting milk testing 4 per cent fat for the skim milk and the amount of this needed to reduce the 32 per cent cream to 18 per cent cream may be found.

In this case mixing equal quantities of 32 per cent cream and 4 per cent milk gives 18 per cent cream and if 100 lbs. 18 per cent cream are wanted mix 14–28 or ½ = 50 lbs. 32 per cent cream with 14–28 or ½ = 50 lbs. 4 per cent milk.



Weight of cream to be added to given weight of milk to make cream of given test. If 50 lbs. milk testing 4 per cent fat are to be made into cream testing 20 per cent fat by using 30 per cent cream according to these figures the milk and cream must be mixed in the proportion of 10–26 milk to 16–26 cream and 50 lbs. milk will require 10 : 16 :: 50 : X = 80 lbs. 30 per cent cream to make a cream testing 20 per cent fat.



Mixing butter and skim milk to make cream. If cream testing 18 per cent fat is wanted from butter containing 80 per cent fat which is to be added to skim milk the proportions of each needed are as follows: Showing that 18 lbs. butter fat mixed with 62 lbs. skim milk will make 80 lbs. cream testing 18 per cent.

Calculating the lbs. cream of a given test that can be made from a given weight of butter. How many lbs. 18 per cent cream will 40 lbs. butter make if the butter contains 80 per cent fat? This may be calculated from the figures obtained above and gives 18 : 62 :: 40 : X = 138 lbs. skim milk to which 40 lbs. butter are added, making 178 lbs. 18 per cent cream.

Another simple method of making the necessary calculations in standardizing milk or cream is to multiply the weight of cream by its test and divide the product by the figure representing the standard wanted. If 500 lbs. cream testing 30 per cent fat is to be reduced to cream testing 25 per cent fat the calculation is made as follows: $500 \times 30 = 15000$ and $15000 \div 25 = 600$ showing that 500 lbs. cream testing 30 per cent fat will make 600 lbs. of cream testing 25 per cent fat by adding 100 lbs. skim milk to the 500 lbs. 30 per cent cream.

A still shorter way to make the necessary calculations is to subtract the test of the standard cream which in this case is 25 per cent from the test of the cream to be reduced or 30 per cent, then multiply the pounds of cream to be standardized by this difference, 30—25 = 5 and $5 \times 500 = 2500$,

which 2500 ÷ 25 = 100 lbs., the weight of skim milk that must be added to the 500 lbs. 30 per cent cream to reduce it to cream testing 25 per cent fat. If cream is to be standardized with whole milk of a certain test instead of skim milk the calculation may be made in the same way by dividing the product by the difference between the test of the milk used and the figure representing the standard wanted. In the above calculation if milk testing 4 per cent fat is to be used instead of skim milk then divide the 2500 by 21, which is 25—4 = 21 and the amount of 4 per cent milk needed will be 2500 ÷ 21 = 119 lbs. which added to 500 = 619 lbs. cream testing 25 per cent fat.

Another illustration of this method of calculation may help to make it clearer. If 350 lbs. cream testing 28 per cent fat are to be made into cream testing 18 per cent fat by using skim milk the lbs. skim milk needed may be found as follows:

28—18 = 10 : 350 × 10 = 3500:

3500 ÷ 18 = 195 showing that 195 lbs. skim milk added to 350 lbs. cream testing 28 per cent fat will make 545 lbs. cream testing 18 per cent fat.

If milk testing 4 per cent fat is used instead of skim milk then 28—18 = 10 and 350 × 10 = 3500 and 18—4 = 14 and 3500 ÷ 14 = 250 therefore 350 lbs. cream testing 28 per cent fat + 250 lbs. milk testing 4 per cent fat = 600 lbs. cream testing 18 per cent fat.

A Crust on Bottled Cream

A Crust on bottled cream may be caused by:

1. Too much agitation of the milk during the pasteurizing or the cooling process.
2. Unsteady running of a cream separator bowl.
3. Any excessive agitation which the milk or the cream may receive from the time it leaves the cow until it is delivered to the consumer as bottled cream.

Remedy: One of the first things to do when customers complain of a crust at the top of a bottle of cream is to

inspect the kind of stirring which the cream gets during the pasteurizing process.

It is necessary that milk or cream should be kept in motion while it is being heated: but this motion should be uniform and not very vigorous, especially at the time the cream passes through the churning temperature around 60° F., while it is being heated up to the pasteurizing temperature, and also when passing through the same churning temperature during the cooling process.

It sometimes happens that sweet cream is bought from farmers, and the farm separator does not run smoothly. The bowl may shake or run unsteadily during the skimming process. It is well to investigate all the separators used for skimming the cream bought, and notice the vibration, if any, of the separator bowls. They should run with a steady, uniform motion during the time the milk is skimmed.

The agitation of the cream, either by the separator or by the stirrer in the pasteurizing process, has a tendency to partially churn some of the cream, and the small fat drops which may be separated will rise to the surface in the neck of the cream bottle and form the hard crust which is so objectionable to the bottled cream buyers. Avoiding such agitation prevents the formation of this crust.

No Cream Line on Bottled Milk

No cream line on bottled milk may be caused by:

1. Thin milk.
2. Pasteurizing the milk at too high a temperature.
3. Failing to cool the milk low enough after pasteurizing it.
4. Very small fat globules in the milk, as is often the case during the last month of a cow's lactation period.

Remedy: It has been found by heating milk to different temperatures that 145° F. will destroy the bacteria in the milk and prolong its keeping quality if this temperature is held a long enough time; and, further, that a higher temperature than 145° F. held a short time changes the condition of

the fat globules so that the cream does not rise well on such milk. If the pasteurizing or heating process is carefully watched and the temperature never exceeds 145° F. and further if this temperature is held for twenty minutes, such milk, after heating and cooling, will retain its cream rising properties and a cream line will appear in the neck of the bottles in the same way that it does on raw milk or milk that has not been pasteurized.

If it is possible to allow bottled milk, after pasteurizing, to stand at a cold temperature, around 40° F., for twelve to twenty-four hours after pasteurizing, this will aid in giving such milk a pleasing appearance in so far as the cream line is concerned, and it will also help the flavor of the milk.

The important thing in pasteurizing milk for bottling and delivery to customers in a condition that will show the cream line, is to be careful in heating the milk and not let the temperature go above the figure mentioned, 145° F.

It is equally important that such pasteurized milk should be cooled as rapidly as possible down to a temperature near 40° F. and then held at this temperature for a number of hours before delivering it to customers.

Ropey Milk

Ropey milk may be caused by:

1. Inflammation in the udder of one or more of the cows in a herd.
2. A certain kind of bacteria that gets into the milk from the dust and dirt of a pasture or a cow stable.
3. Impure water used for washing milk cans, pails, etc.
4. Failing to sterilize with hot water or steam all the milk pipes, faucets, valves, and utensils at either the farm or the factory.

Remedy: Ropey milk is made by cultivating a special kind of bacteria in milk. It is especially sought as a desirable food in some European countries, but in this country ropey milk is considered an abnormal condition of milk and un-

desirable, although it is harmless to the health of persons drinking it.

Ropey milk is noticed in the spring and summer, especially in a wet season when cows wade through mud, and this is not entirely washed from their udders just before milking. In such cases, the bacteria may be kept out of the milk by thoroughly cleaning the cow's udder, wiping dry with a damp cloth and by thoroughly steaming the milk cans as well as the milk pipes of a city milk plant.

Thoroughly steaming and sterilizing all the utensils and pipes through which milk passes kills the bacteria.

When ropey milk is caused by the milk of some one cow, or the milk from some one of a member of patrons, at a city milk plant, its source may be located by placing about one half pint of each lot of milk in a clean bottle using as many bottles as there are cows, or patrons. These bottles are then placed in a warm room until the milk sours. If any particular cow or patron's milk is responsible for the ropey milk this will be shown by the condition of the milk in each bottle after standing some hours.

After locating the source of the trouble it will be necessary either to visit the farm and isolate the one cow in the herd from which the ropey milk is obtained; or, if all the milk from one herd is ropey a general cleaning and scalding of all the tinware as well as the cleaning of each cow's udder before milking will undoubtedly protect the milk from this particular kind of bacteria. The same steaming and sterilizing is also sometimes needed at the milk bottling plant.

Packing Butter for Winter Use

At the present time butter is held in cold storage warehouses for many months at very low temperatures and excellent results obtained. Occassionally, however, inquiries are received for information about the old fashioned "salting down" method by which butter made during the summer and fall is placed in jars and held for winter use.

In making such butter the best possible results are obtained by churning as sweet a cream as possible, and if it can be so arranged, the cream may be pasteurized, that is, heated to a temperature of about 145° F. for 20 minutes, then cooled to about 50° F. and held at this temperature over night, in

order that the cream may be in first class condition for churning the next morning.

The churn should be less than half filled with this cream and the buttermilk drawn off as soon as the butter comes in granules the size of wheat kernels. The churn is then about half filled with clean, cold water to wash the buttermilk from the granular butter. This wash water is drawn off and a second washing of water added. After drawing off the second wash water, the butter may be salted in the churn at the rate of about one ounce of salt for one pound of butter and the usual amount of working given to incorporate the salt thoroughly.

It is important in making long keeping butter, that as much buttermilk as possible should be removed before salting the butter.

When the butter is worked sufficiently, it can be placed in stone jars which have been thoroughly steamed and cooled, packing the butter in these jars and spreading about one inch of salt over the top of the butter in the jar. A piece of parchment paper or white cloth is usually placed on top of the butter before covering with salt.

In case it is desired to put up the butter in one or two pound packages, these can be made in the same way as already described in so far as the churning, washing and salting of the butter; but after the bricks of butter are made, they can be wrapped in parchment paper and placed in a large crock or other receptacle, filled with strong brine. This brine liquid is usually made by adding salt to hot water and stirring in the salt as fast as it will dissolve. A brine made in this way should be heated to a temperature of at least 180° F. and then cooled down to 50° F. before the bricks of butter are placed in it. Such brine will keep the butter in good condition if the jar containing them is held at a cool temperature, say below 60° F., and the nearer 50° F., the better.

Both of these methods of "salting down" butter for the winter are used somewhat; and the length of time butter is kept depends a great deal on first thoroughly washing out the buttermilk from the granular butter and then keeping the packed butter in a cool place. The farm house cellar is usually about the only place on the farm where such butter can be kept.

Thunder Does not Sour Milk

The claim that thunder and lightning turn milk and cream sour may be explained by the fact that a thick, sultry atmosphere usually precedes thunder showers and provides favorable conditions for the growth of milk-souring bacteria.

In a clear, cold air or a dry air, milk or cream sours more slowly than in a thick, warm, sultry air.

Another thing that hastens the souring of milk on the farm by a thunder storm is the condition of the milk cans. In case the milk is nearly sour anyway, due to the sour cans in which it is kept, and a thunder shower comes up, the heat and moisture in the air aid the multiplication of bacteria in the milk and cream so that the souring proceeds rapidly.

No effect from thunder and lightning on milk and cream will be noticed if the cows are clean, the milk cans clean, and all the utensils carefully sterilized with hot water before the milk or cream is added to them, and the filled cans are placed in cold water and kept cold during a thunder storm.

Winter Dairying

Winter dairying is profitable for the following reasons:

1. Cows fresh in the fall are fresh twice a year.
2. A fall calf will grow faster than a spring or a summer calf because the latter, during its early life has to endure hot weather and fight flies.
3. Farm help used in the summer for raising crops may be profitably employed during the winter, feeding and milking the cows, especially if the cows are fresh and give large quantities of milk.
4. The price of dairy products is higher in winter than in summer.
5. Raising crops for winter feed is a more economical use of the land than summer pasturing.

When a statement is made that a cow fresh in the fall is fresh twice a year, this means that cows freshening in October and November, if kept in a warm stable and well fed, will produce a maximum amount of milk during the winter

season and when spring comes if the cows are turned out to pasture, the change from stable to pasture feed will stimulate the production of milk so that they will give milk during a much longer period of time than would be the case if the cows are fresh in the spring and give their maximum amount of milk during May and June, after which they gradually dry up in the early fall.

Records have shown that a cow fresh in the fall will give much more milk during the year than the same cow fresh in the spring if she is comfortably housed and abundantly fed during the winter.

A calf beginning life in the fall and kept in a warm stable is not annoyed by flies as is the case when it is born in May or June.

The farm help has more time during the winter to care for the cows than is the case during the spring when crops require attention.

The dairy cow is, in a certain sense, a machine, and this machine can be as well fed and cared for during the winter season as through the summer, if the stable, labor and feed are available.

Whipping Cream Difficulties

Whipping cream difficulties may be overcome by:

1. Cooling the cream to near 50° F. or lower.
2. Increasing the richness of the cream to at least 25 per cent fat.
3. Ageing the cream for 48 hours or more before whipping it.
4. Using the modern cream whipping appliances.

Cream whipping troubles are usually caused by attempting to whip cream with a spoon in a bowl or by using the old-fashioned wire, broom-like whipping device which is revolved by turning a crank while holding the wire cage in a vertical position in a dish containing the cream.

By ageing the cream, that is, by keeping it in a cold place for 48 hours or more, certain changes seem to take place in the nitrogenous constituents of the cream, increasing its

viscosity and thereby holding the air better than is the case when the same cream is whipped fresh from a separator.

Cream testing even so low as 20 per cent fat may be easily whipped if it is held at a cold temperature near 50° F. for at least one day and then the whipping done in a bowl or dish that has been placed in ice to cool so that the cream is not warmed during the whipping process.

A rich cream will whip easier than a thin cream, but there is more danger of churning the rich cream during the whipping process, especially if the cream is allowed to become warm or is placed in a warm dish for whipping.

The modern whipping appliance which resembles a turbine wheel attached to a vertical standard, will whip nearly any kind of sweet cream, although the age of the cream has some influence on the results obtained even with this appliance.

The effect of temperature and test of cream on its whipping is shown by the following demonstration:

A cream testing 20 per cent fat, which is a thin cream, was held at a temperature of 50° F. for 20 hours. This cream whipped in four minutes.

Another portion of the same cream was warmed to 70° F., and soon after the whipping process started, it churned to butter.

Still another portion of the same cream was held at a temperature of 50° F. for 60 hours and this whipped quicker and more satisfactorily than the cream held only 20 hours.

The age of the cream is of more importance than its richness, and the cooling of the cream and whipping in a cold place with the modern cream whipper is more important than any of the other factors that influence household cream whipping.

Why Dairying is Profitable

Cows have been milked for many centuries, but no great attention was given to the development of the dairy cow as a milk producer or to the manufacturing processes of butter-making and cheesemaking, until the three following events occurred in the history of dairying: 1. A change from farm to factory manufacturing of butter and cheese. 2. The in-

vention of the centrifugal cream separator. 3. The invention of the Babcock Milk Test.

After the value of factories and of the cream separator and the milk tester was thoroughly understood the dairy industry began to grow rapidly along three lines:

1. Improvement of dairy manufacturing processes.
2. The study of economical milk production.
3. The marketing of dairy products.

The statement is often made that dairying has lifted the mortgage from many a farm. The truth of this assertion has been proven over and over again and numerous illustrations might be cited to show that there are farms, counties and even states which owe their present prosperity largely to dairying.

In making a survey of agricultural sections of the country it will be noted that there are very few, if any, bank failures in agricultural localities where farmers own and milk cows. In fact, when a dairyman wants to borrow money at a bank the question usually asked him is, how many cows he milks; and if he owns the cows and is milking them, he has little difficulty in borrowing the money he needs.

The owner of a farm on which cows are milked has some or all of the following advantages over the general crop farmer, who milks only a few or no cows:

1. Dairy products are not bulky to market. Very few farm products are sold for so high a price per pound as milk, cream and butter. The difference in transportation charges on dairy products and on crops sold from the farm may be illustrated by comparing a ton of hay which may sell for $20.00 and is rather bulky to deliver, with the marketing of a ton of butter, which may sell for $1,000.00.

2. The Dairyman is a manufacturer. The cows he milks are the machines and the crops he raises are the raw material which is manufactured by the cow machines into a high priced, and readily salable product. The dairy farmer has the same opportunities that any other factory owner has of giving his attention to the saving of waste and the improvement of the quality of his product in order that he may receive the highest prices for it.

3. **Dairying utilizes waste land.** On farms where there are marshes, timber or rocky hills, the cows may be pastured in these places and thus convert the feed growing there into a high priced and salable product.

4. **Dairying requires only a small capital to begin with.** One cow may cost $100.00 and her milk is salable immediately for cash, which will help to buy another cow; and more milk will make it possible to increase the herd gradually until the owner is comfortably supplied with cows enough to make the farm a profitable investment.

5. **Dairying is especially adapted to high priced land.** If one cow can be kept for every two acres of the farm and each cow produces 6,000 pounds of milk in a year, the $120.00 received for this 6,000 pounds of milk is a good return from the two acres of land; or, if the farm will only support one cow for each four acres, the $120.00 received for the 6,000 pounds of milk in a year is a return of $30.00 per acre, which is more than is obtained from some farms on which no cows are kept.

6. **A dairy farmer has a steady income throughout the year.** By milking cows he is harvesting his crops during the entire year.

7. **A dairy farm supplies profitable employment for labor every month in the year.** During the summer months crops suitable for cow feed are raised and in the winter feeding and milking the cows gives employment for the same farm hands that work the land through the growing seasons.

8. **The feeding value of skim milk and whey for calves, pigs, and chickens,** can not be equaled by any other feed. Feeding experiments have shown that 100 pounds of skim milk is worth for feeding pigs as much as one-half a bushel of corn, and cheese whey is worth one-half the value of skim milk.

9. **Dairying prevents soil exhaustion.** The fertilizing constituents most commonly needed to grow abundant crops are nitrogen, phosphoric acid, and potash. Analyses of the different farm crops and of dairy products show that these fertilizing constituents in a ton of butter are worth about

fifty cents, while the fertilizing constituents in a ton of hay are worth $4.30; in a ton of corn, $5.30; in a ton of wheat $6.60.

One ton of butter contains about 1640 pounds of fat, 280 pounds of water, 20 pounds of milk sugar, and 20 pounds of casein and mineral matter. The first two substances, fat and water, comprise 1920 pounds of the ton and these constituents come from the air, the sunshine and the water on the farm, they do not exhaust the fertility of the soil.

The nitrogen, phosphoric acid and the potash taken from the soil by the ton of butter are all found in the 20 pounds of casein and mineral matter which is a comparatively small part of the ton. No other farm crop removes so little fertility from the land as butter and cream.

In a ton of mixed hay there are about 220 pounds of mineral matter and protein, in a ton of corn 240 pounds and in a ton of wheat, 275 pounds, and since these constituents are similar to the ash and casein of the butter, it is evident that the hay, the corn and the wheat are from eleven to fifteen times more exhaustive to the soil than is the butter or the cream, which sells for $1,000.00 per ton, while the ton of hay sells for about $20.00.

The case is somewhat different when milk is sold from the farm. A ton of whole milk removes from the soil about 88 pounds of nitrogen, phosphoric acid and potash or over four times as much as a ton of butter removes. This difference between milk and butter is largely due to the casein in the milk, but this fertility is returned to the farm if the skim milk is kept at home and fed to calves, pigs and chickens.

In addition to retaining the fertility in the farm crops, when these are fed to cows, all the grain feeds bought and fed the cows also contribute at least 80 per cent of their mineral constituents to the farm fertility.

A cow produces from 12 to 15 tons of manure per year, and if this is valued at $2.00 per ton, the fertility of the land may be increased by at least $25.00 worth of fertilizer.

When crops are grown on the farm and fed to live stock, and the manure is carefully saved and applied to the land, it is possible to return to the soil at least 80 per cent of the fertilizing constituents taken from the soil by the crops.

10. Finally, since the human population increases faster than the cow population, there is no danger of an overproduction of dairy products, and their exceptionally high food value will make them always in good demand at a profitable price.

The statement has been made that a mature dairy cow in a year produces in her milk as much human food as the carcasses of several steers. A 1,200 pound steer ready for market supplies only about 400 lbs. of human food. A dairy cow begins at two years of age to produce about 5,000 lbs. of milk which contains at least 600 lbs. of solid, edible human food, and if she continues milking for 7 years, contributes a total of 4,200 pounds during her lifetime, and it will take the carcasses of about 10 steers to produce this amount of food.

A good daily gain in weight of a steer is 2 to 3 pounds, live weight and this is half water.

A cow giving 50 lbs. of milk per day manufactures 6 pounds of solid, digestible human food, and to equal this a steer would need to have 10 lbs. of steak cut from his carcass every day.

It is claimed that a dairy cow produces food more cheaply and economically than any other domestic animal.

Dairying Gives a Profitable Return for Study. No branch of farming gives a greater opportunity for thought and study than does dairying, and no other line of work gives better returns for intelligent thought as well as skill and expertness in management than does the production of milk from profitable cows. The problems of breeding, feeding and the economical production of milk in all its details are constantly before the dairyman and on the correct solution of these problems depends his prosperity.

The points already mentioned in favor of dairying could be still further added to without exaggeration, but those given will apply to any community. It often happens, however, that certain localities offer greater advantages for some lines of farming than others, and this may be profitably considered in dairying.

Importance of Farm Location on Dairying. The distance from market is an important factor in determining the kind of dairying best adapted to a given locality.

On high priced land near a city the selling of milk directly to the consumer or to a city milk dealer is a common practice. A high price is usually paid for such milk and since it can be delivered quickly and in good condition with small cost of transportation, milk selling is usually the most profitable line of dairying to follow when a farm is located near a large city. Selling sweet cream to ice cream dealers is also profitable, especially when the farm is so located that the cans of cream can be quickly and easily delivered to the city buyer.

Farms located beyond the reach of a city demand for milk, find the local creamery, cheese factory or condensery a profitable enterprise to patronize. The creamery takes the cream, leaving the skim milk on the farm, and this is worth about twice as much per hundred pounds for feeding pigs as the whey returned from a cheese factory. A condensery uses all the milk, returning nothing to the farm but the empty can, and on this account pays more for milk than a creamery or a cheese factory.

Farm buttermaking and the shipping of a can of sour cream long distances by truck or railroad gives the isolated farmer a market for the product of his cows, but the quality of the product made from such cream is not always of the highest, although farms so located will probably receive more for the butter or cream sold from the farm than they will for any other product of the farm.

CHAPTER VII

Some of the Constituents of Milk

The principal constituents of milk are:

1. Water.
2. Fat.
3. Casein.
4. Albumen.
5. Milk sugar.
6. Mineral substances, or ash.

Although milk has been studied and analyzed by scientists for many years, it is still one of the most mysterious products with which the chemist has to deal. Two of the constituents of milk, the water and the milk sugar, are comparatively simple substances, but the fat, the casein and the ash are very complex. New compounds in minute quantities are occasionally being separated from even these constituents at the present time.

A great many tests have been suggested for the use of dairymen or anyone not a chemist for the purpose of determining some of the qualities of milk and of its products. In order to use these tests to the best advantage a knowledge of the reasons for obtaining certain results as well as a study of the composition of milk and of its component parts will be helpful to anyone interested in the production or the manufacture of dairy products.

Definitions of some of the common terms used in discussing the component parts of milk.

Normal whole milk or unskimmed, sweet milk always contains the same constituents, but in varying amounts. The simplest division of milk into its component parts is to evaporate the water and note the amount of residue left. This residue is given various names, such as "total solids," "dry matter," "milk solids." Average milk contains about 12.7 per cent total solids, and 87.3 per cent water.

Another term frequently used in discussing milk is "serum." This is well illustrated by skim milk. Milk serum is what is left after taking out all the butterfat. In average milk the serum is 96.3 per cent, and the butterfat 3.7 per cent.

When the milk serum is evaporated to dryness, the residue left is called "solids not fat," or the total solids minus the fat, and in normal milk it is usually about 8.5 per cent.

Many tabulated statements of the composition of milk have been suggested. The following arrangement may be helpful in showing the manufacturers of different dairy products, how the principal constituents of milk are distributed in these products. This list does not contain the names of all the constituents that have been found in milk, especially in the butterfat, the casein and the ash, but a few of these are given to aid the dairy manufacturer and the dairy farmer in understanding how the milk constituents are distributed in manufacturing some of the various dairy products:

Composition of Milk

Fat 3.7	Olein — liquid Stearin — solid Palmitin — solid Butyrin — volatile		3.7	Cheese solids
	Casein —		2.5	
	Insol. Ash —		0.3	
	a		b	
Serum 96.3	Soluble Ash —		0.4	
	Albumen —		0.7	
	Milk sugar —		4.7	Whey
	Organic Acids		0.4	
	Water —		87.3	
		100.0	100.0	

Total solids — 12.70 Solids not fat — 9.0
Constituents above line a–b are in suspension.
Constituents below line are in solution.

The variations from these figures in normal milk from different cows may come between the following figures:

Water per cent — 83 to 91.	Albumen — .2 to 1.3
Fat per cent — 2 to 8.	Milk sugar — 3. to 6.6
Casein per cent — 2 to 4.5.	Mineral matter — .6 to 1.

The figures refer to cow's milk, and while the milk of one cow may vary in composition from one milking to another, the mixed milk from a herd of cows is comparatively uniform in composition from day to day. In former years the milk of one cow was supposed to be preferable to herd milk for infant feeding, but at the present time this opinion is not held because of the much greater variation from day to day in the

composition of one cow's milk as compared with that of the mixed milk from several cows. Herd milk is now considered better for infant feeding than the milk of one cow.

Colostrum Milk

This is the milk secreted in the udder for a few days after parturition. It differs from normal milk in color, taste and in composition, having a yellowish color, strong odor, salty taste and when examined under the microscope shows clusters like bunches of grapes. By standing it separates into two layers. It is coagulated by boiling.

Cow's milk should not be used until after the seventh milking, at which time it commonly has become normal in composition, although this varies with different cows. The changes in composition from colostrum to normal milk are shown in the following table:

Composition of Colostrum Milk

After Calving	Solids	Fat	Casein	Albumen	Sugar	Ash
0 Hours	26.83	3.54	2.65	16.56	3.00	1.18
10 Hours	21.23	4.66	4.28	9.32	1.42	1.55
24 Hours	19.37	4.75	4.50	6.25	2.85	1.02
48 Hours	14.19	4.21	3.25	2.31	3.46	0.96
72 Hours	13.36	4.08	3.33	1.03	4.10	0.82

These figures show that colostrum differs from normal milk in containing less sugar, more albumen and more ash. The fat is a trifle lower, but contains less volatile fatty acid. Colostrum milk injures the flavor of cheese, but it does not necessarily change the flavor of butter, because the excessive amount of albumen and other constituents of colostrum milk are removed in the buttermilk.

A good test for colostrum milk is to heat the milk to boiling. If sweet, a coagulated cake separates on boiling, this is probably caused by using the milk of some cow too soon after calving. When examined with a microscope many leucocytes will be seen in colostrum milk.

The Composition of the Milk of Various Animals*

Animal	Water	Fat	Sugar	Casein	Albumen	Ash
Cow	87.10	3.9	4.75	3.00	.40	.75
Goat	86.04	4.63	4.22	3.49	.86	.76
Ewe	79.46	8.63	4.28	5.23	1.45	.97
Woman	88.2	3.3	6.8	1.0	.5	.2
Mare	89.8	1.17	6.89	1.	.84	.3
Sow	84.4	4.55	3.13	7.23		1.05
Cat	81.63	3.33	4.91	3.12	5.96	.58
Elephant	67.85	19.57	8.84	3.09		.65
Whale	48.67	43.67		7.11		.46

*Richmond's Dairy Chemistry.

The milk of sheep and goats is used for human food in some sections of the world. In Southern France, where sheep are milked extensively and Roquefort cheese is made, the production of milk is about 150 lbs. per animal per season, although a sheep weighing 120 lbs. has given so much as 460 lbs. of milk in eight months, or about 2.0 lbs. per day.

Cream does not rise readily on sheep's milk because the fat globules are small and the serum viscous due to the high percentage of casein and albumen in the milk. Some cream can be obtained from sheep's milk by first diluting it with water and then skimming it with a centrifugal separator. The butter, however, is soft and spoils quickly.

Goat's milk is usually richer than cow's milk. The fat globules are smaller and it can be skimmed less efficiently than cow's milk. It is claimed that goats are less subject to tuberculosis than cows. Goats give large quantities of milk; 2,000 lbs. of milk has been given by a 100 lb. goat in one season of ten months.

The Butterfat in Milk

When a drop of milk is examined under a microscope the minute fat globules can be seen floating in the serum. The size and the number of these fat globules may be determined

by counting them in a capillary glass tube of known diameter by means of a microscope.

Figures expressing the number and the relative size of fat globules are given in various textbooks. The numbers given mean that that number of fat globules was counted in one-ten-thousandth of a cubic millimeter, and the relative size is found by dividing the per cent of fat in the milk by the number of fat globules counted in this way.

By counting the number and computing the size of the fat globules in the milk of single cows and of herd milk, it has been found that the fat globules in the milk of the Holstein and the Ayshire are usually smaller than the fat globules in the milk of the Jersey and the Guernsey cows, and further, that the fat globules in the milk of a cow when she is fresh are larger than the fat globules of the same cow when she is late in her milking period or a "stripper."

Various expressions have been used to give some conception of the actual size of the fat globules in milk such as:

1. The average diameter of the fat globules in milk is one-six-thousandth of an inch. The diameter varies from one, one-thousandth to one twenty-five-thousandth.
2. There are said to be from one to five million fat globules in a drop of milk the size of a pin head.
3. It may take from twenty to thirty fat globules placed side by side to equal the thickness of a sheet of writing paper.
4. It would take ten years to count the number of fat globules in one quart of milk at the rate of ten per minute, working ten hours per day.

Although the size of the fat globules in milk is an individual characteristic of the animal, it is influenced somewhat by the feed but mostly by the lactation period. The fat globules are smaller when the cow is nearly dry than when she is a fresh milker.

The Variation in the Size and the Number of the fat Globules in Milk

The variation in the size and the number of the fat globules in milk helps to explain many of the changes noticed in manufacturing dairy products, such as:

1. The efficiency of cream raising by a gravity process.
2. The quickness and the efficiency with which cream will churn.
3. The losses of fat in the whey when making cheese.
4. The appearance of a cream line on bottled milk.

Grouping of the Fat Globules

In freshly drawn milk the fat globules are evenly distributed through the serum, but in a short time they begin to gather into groups or clusters. These are held together by some invisible material which Dr. Babcock has suggested is similar to the fibrin in blood. In fact the fat globules in milk have many similar actions to the white corpuscles in blood and conditions that cause as well as those that prevent blood from clotting have a similar action on the grouping of the fat globules in milk and cream. The white corpuscles move freely in the veins of a living animal, but when exposed to the air blood has a tendency to form clots, or the corpuscles group themselves in much the same way as the fat globules are grouped in milk.

This same similarity has been noticed when either blood or milk is agitated, both thicken, and when cooled to 50° F., the coagulation of blood is retarded, and cold also aids cream raising by gravity.

By examining milk and cream under the microscope it has been found that any treatment which groups the fat globules tends to increase their viscosity or thickness and any treatment that breaks up the groups tend to decrease this viscosity and make the milk and cream appear thinner. This change in the grouping helps to explain several common conditions of dairy products, such as the thinner appearance

of separator cream of the same richness as gravity cream; also the thinner appearance of pasteurized as compared with raw cream.

Hard and Soft Butter

The component parts of milk fat are called "triglycerides of the fatty acid." This means that chemically speaking, glycerol is combined with the fatty acids, of which there are many in milk. Some of these glycerides are butyrin, stearin, olein, palmatin. Besides these there are many others present in smaller quantities, but these four help to give butter some of its characteristic properties.

Butyrin is the characteristic volatile and soluble triglyceride that helps distinguish butter from other fats such as lard, tallow, oleomargarine, etc. When butter spoils or becomes rancid or strong, the butyrin is changed to butyric acid, but so long as it is unchanged it gives to butter a part of its butter flavor.

Olein is an oil and the part of butterfat which has a tendency to make it soft. Olein melts at a temperature of 41° F. Palmatin, stearin, and other hard fats are somewhat like tallow and give butter its hardness and firmness. These fats melt at a temperature of 130° F. to 150° F. The hardness of butterfat, therefore, depends largely on the relative amounts of olein, stearin, etc., present.

The melting point or temperature of butter varies from 84° F. to 104° F., according to the proportion present of stearin, which melts at 141° F., palmatin, which melts at 146° F., and olein, which melts at 41°F.

The fats in a cow's feed do not pass unchanged into her milk, but the processes of digestion and assimilation transforms the feed fat into milk fat. It has been found that normal milk containing the usual percentage of fat is produced by a cow when she is given feed containing no fat. The digestive system is capable of producing milk fat from other food ingredients, such as protein and carbohydrates. It has often been shown that feeding fats like tallow, oil, etc., in a cow's rations does not increase the richness or the per cent of fat in the milk a cow gives.

The Casein in Milk

Casein is the principal constituent of the curd in milk. It is one of a group of substances which contain nitrogen as well as carbon, hydrogen, and oxygen. Milk fat contains carbon, hydrogen, and oxygen only. Milk contains a number of nitrogenous compounds, but casein is the one present in the largest quantities. Casein is next in importance to the fat, although it does not vary so much, generally ranging from 2 per cent to 3.5 per cent.

In herd milk the per cent of casein may not vary from day to day more than .3 per cent. Casein is a white substance with neither taste nor smell. A small part of it is in suspension, but most of it is in solution in the serum of sweet milk.

The casein in suspension is so finely divided that it cannot be seen with a microscope, but when milk is curdled by souring or other means the casein separates as coagulated curd.

Both rennet and pepsin may be used to curdle or coagulate milk, although these will not give the characteristic curd usually made into cheese unless a soluble lime salt is present in the milk. One explanation for the failure of sweet, pasteurized milk to curdle or coagulate in a normal way when either rennet or pepsin is added to it is that the heat has changed the lime and other salts in the milk in such a way that rennet or pepsin does not give the same kind of a curd that is obtained when these are added to milk which has not been heated. It has been found that the normal coagulating property of heated or pasteurized sweet milk may be restored by adding a small quantity of a dilute acid to milk after heating it. This practice has been used to some extent in making cheese from pasteurized milk.

The Albumin in Milk

This is a nitrogenous constituent of milk that is similar in nearly all respects to blood albumen and to white of egg. It differs from casein in its lack of phosphorus and in the small amount of sulphur it contains. Albumen is coagulated by heat, but not by acid or rennet. Milk may be heated to at least 140° F. before the albumen begins to coagulate, but if heated continuously to a higher temperature, all the albumen will be coagulated. When heated quietly and exposed to the air more albumen separates than when heated in a closed receptacle and stirred. In making cheese the albumen remains in the whey.

Milk Sugar

Milk sugar or lactose is found in milk only. The amount of milk sugar in cow's milk is fairly constant, usually about 4.7 per cent. It may, however, vary one per cent above or below this figure. When milk sours, the milk sugar or lactose is changed to lactic acid. When pure, milk sugar is a colorless crystaline substance, about one-third as sweet as cane sugar. It is not so soluble in cold water as cane sugar. The lactic acid bacteria which sour milk or change lactose to lactic acid grow slowly at a temperature of 50° F., but they grow rapidly at about 100° F. As the temperature rises above 115° F. their growth begins to weaken, and at temperatures of 140° F. and higher, the lactic acid bacteria are destroyed.

Milk sugar may be prepared by evaporating the whey left from cheesemaking. The albumen is separated by boiling the whey and adding lime enough to neutralize the acid in the whey. It is then heated until the water evaporates and the milk sugar crystalizes out. This is then purified by re-crystalization and treatment with animal charcoal or alcohol.

The demand for milk sugar is not at the present time very great and its manufacture is not extensive.

The Mineral Constituents in Milk

The ash in milk includes the mineral elements necessary to build up the body of a young animal, such as phosphorus sulphur, carbonates, potassium, sodium, calcium, iron, etc. About two-thirds of the mineral matter of milk is in solution, largely composed of soluble salts of lime which are necessary, for the coagulation of milk with rennet as in cheesemaking. The insoluble mineral constituents are mostly phosphates of magnesia and lime. Some of the lime is combined with casein. A small quantity of citric acid combined with some of the mineral elements is also present in milk.

The ash (or mineral constituents of milk) has an important influence on:

1. The viscosity of the milk serum.
2. The movement of the fat globules in the serum.
3. The condition of the casein, a part of which is in a swollen or jelly-like condition.

4. The reaction and the coagulation of milk.
5. The action of rennet on milk.
6. The changes that take place by heating milk, which is illustrated by the difference in cheese made from milk before and after milk is pasteurized.

The Color of Milk

The color of milk varies from a porcelain white to a yellowish or bluish white, depending on:

1. The breed of the cow.
2. The feed of the cow.
3. The amount and the distribution of the butterfat globules through the milk serum.

The color of milk is commonly accepted as an indication of its richness, varying from a bluish, skim milk color to a rich, yellowish, cream color. It is claimed that the reflection of rays of light from the fat and the casein held in suspension in the milk serum, causes the degree of whiteness to vary with the amount of fat and casein in the milk because of the varying number of particles from which light can be reflected. Milk serum, or skim milk is white because of the reflection of light from the casein particles in the skim milk, but milk whey is nearly colorless, like water, because most of the fat globules and all the casein are removed from it. The milk whey allows light to pass through it much the same way as it passes through a piece of clear ice, which is colorless so long as it is in a solid mass, but when chipped or pulverized into small particles each one of these becomes a reflecting surface and the finer the chipped ice, the whiter it is until it becomes snow white.

The effect which the breed of the cow or the individual characteristics of a cow of any breed, has on the color of the milk, is well illustrated by the characteristic yellow color of the Guernsey milk, which, as is generally known, is a deeper yellow color than the milk of most other breeds.

The effect which the feed of a cow has on the color of her milk is noticeable when cows are changed from stable to

pasture feed in the spring. Green feed such as pasture grass and corn silage, as well as some other feeds like corn meal and clover hay, usually deepen the yellow color of milk, while other feeds, like cottonseed meal and straw have a tendency to lighten the color.

The Foam on Milk

The foam on milk may be caused by:

1. The air forced into milk during milking.
2. The centrifugal cream separator.
3. The heating or pasteurizing of milk.
4. Any agitation of the milk or cream, which has a tendency to mix air with them.

The amount of foam on milk is influenced largely by the viscosity of the milk, and this varies with the solids in solution. As a rule milk low in solids, foams less than rich milk, and milk twelve hours old foams less than fresher milk.

The amount of foam is influenced by the strength with which the air is forced into the milk, whether this is done by milking the cows, by the centrifugal cream separator, or by the arrangement used for pasteurizing the milk. A vigorous milker forces more air under greater pressure into milk and makes more foam than a slow milker, and the high speed of a centrifugal cream separator bowl forces more air into the milk than a low speed machine of any kind which is used to agitate or stir the milk.

Chemists have analyzed the air or gases obtained from milk, and found that in 1000 c.c. of sweet milk there are about 70 c.c. of gas, and by boiling milk the gas is reduced to about 15 c.c. An analysis of this gas shows it to contain about 60 per cent carbondioxide, 10 per cent oxygen, and 30 per cent nitrogen. The oxygen and nitrogen are present in the foam in the same proportions they are found in air.

Sour milk contains in 1,000 c.c. about 150 c.c. of gas, made up of 75 per cent carbon dioxide and 25 per cent oxygen and nitrogen mixed in the same proportion as in the air.

The higher percentage of carbon dioxide in the gases found in sour milk as compared with sweet milk comes from

the fermentation of the milk sugar, which is changed by the souring process into lactic acid and carbon dioxide.

The gases in milk may easily be removed by heating and especially by boiling, one observer finding only about 15 c.c. of air or gas in milk which had been boiled five minutes.

The Odors in Milk

The odors commonly noticed in milk may have their source from:

1. The surrounding air during milking.
2. The air of the place where the milk or cream is kept after milking.
3. Strong flavored feeds which contain ingredients that pass through the cow's digestive system into her milk.

Such odors as "barny," "stable," and "cowy" may easily be removed from milk by aerating it, or they may be kept out of the milk by appropriate ventilation of the stable and the milk house where the milk is kept before it is delivered to a buyer.

Those odors that come from the feeds eaten, such as turnips and too much pasture grass, will not be noticed after the cow's system becomes accustomed to this sudden change of feed.

The odors in milk, cream, butter, or cheese, that come from wild onions, leeks, pasture weeds and other strong flavored feeds, are not removed by aerating the milk, as the odors in these feeds pass through the cow's digestive system into her milk.

Prevention in all cases is preferable to cure for objectionable odors in milk; and aeration or any other treatment of milk is not necessary if the milk and cream are kept in a clean place, the cow protected from eating strong flavored weeds and the milk is cooled immediately after it is drawn from the cow.

The Souring of Milk

The souring of milk is caused by bacteria which get into milk from:

1. The milker's hands.

2. Failure to clean the cow's udder by brushing and wiping with a damp cloth before each milking.
3. Dusty bedding under the cow.
4. Open milk pails used at milking time.
5. Dusty or dirty milk pails which have not been scalded then rinsed and cooled with clean water just before milking.
6. Strainer cloths.
7. Unclean milk cans.

These are only a few of the many sources of bacteria in milk, but they are probably the most common ones.

It has been shown that milk in the udder of a cow is not entirely germ free, but when freshly drawn, milk may contain a small number of bacteria. These, however, are ordinarily of very little importance and can be almost completely ignored if the first few streams of milk drawn from each quarter of a cow's udder at the beginning of milking are collected in a cup or small can and kept separate from the milk obtained from the cow after this rinsing of the milk passages.

Some authorities claim that freshly drawn milk contains a substance which destroys bacteria, because it has been noticed that in some milk, there is no increase in the number of bacteria for a few hours after milking; in fact, the number decreases slightly in some cases. Others claim that the so-called "germicidal" property of milk is simply the result of certain species of bacteria finding milk an unsuitable medium for their growth and consequently they do not develop.

The lactic acid and most other bacteria, however, grow rapidly in milk, and nearly all the germs get into milk after it is drawn from the cow. This shows that the bacteria in milk may be easily reduced by carefulness and cleanliness of the milker and of all other parties handling milk up to the time it is delivered to the factory or to the city milk consumer.

Scientists are continually finding and naming new kinds of bacteria found in milk, and many books and pamphlets have been written on the subject of bacteria in milk; but from the

dairyman's and the manufacturer's standpoint, bacteria in milk may be divided into three classes, the "good" the "bad," and the "indifferent."

Under the head of "good" bacteria may be classed the group of bacteria which produce lactic acid from the milk sugar. These, however, are good bacteria for only the manufacturer of butter and cheese in so far as they aid in the development of desirable flavors in butter and cheese. If however, these good bacteria are too numerous in the milk when it is received at a cheese factory or a creamery, the factory operator can not control the quality of his product. But if a small number of lactic acid bacteria are present and bacteria of other kinds are not mixed with them, they may be called "good germs" for both the buttermaker and the cheesemaker.

Lactic acid bacteria are not however "good" germs for either the city milk dealer, the milk condenser, or the sweet cream dealer. They want germ free milk, for making a sweet and long-keeping product.

The "bad" bacteria include the disease germs such as those which cause typhiod fever, tuberculosis, diphtheria, and many other diseases, also those bacteria responsible for disturbances of the bowels that cause suffering and often death to infants and children.

Another group of "bad" bacteria are those which, by growing in the milk and cream, cause rancid and many other defective flavors in both butter, cheese, and condensed milk.

When one realizes that sixteen million bacteria may grow from one bacterium in twenty-four hours, the necessity of protecting milk from dust, diet, and dirty utensils can be readily understood.

The "indifferent" germs, or bacteria, include a large number that grow rapidly in milk and other dairy products but have no particularly injurious or beneficial effect on the products or on the consumer of the products. This group of bacteria needs no consideration, but the "bad" bacteria are responsible for enormous losses to both the dairyman and the dairy manufacturer. Every particle of dust and dirt in the cow stable may be swarming with bacteria from the alimentary canal of the animals; each hair that drops into the milk while

milking may bring bacteria with it, and flies are invariably bacteria distributors.

It is a well known fact that most of the milk brought to creameries, cheese factories, and condenseries will not keep for more than one day, even in cold weather. The causes of milk spoiling it is well known, are not the fault of the cow. They are innocent of any wrong-doing. It is the person who feeds and milks the cow that is responsible for the bad bacteria in the milk. If the milk producer wants a higher price than he is getting for his milk, no matter to whom he is selling it, the surest way for him to accomplish this is to keep the milk clean and all of the milk utensils thoroughly sterilized with scalding hot water or steam.

Milk produced in the average cow stable, without any special precautions to protect it from bacteria during milking, will contain from 100,000 to 20,000,000 germs or bacteria in one cubic centimeter. (One cubic centimeter equals about twenty drops.)

Nearly all the germs get into the milk after it is drawn from the cow, showing that the number may be easily reduced by carefulness and cleanliness of the milker and all others who may handle the milk up to the time it is delivered to the factory or to the consumer.

The place where cows are kept and the milking is done should be as clean as the place where the milk is consumed. In other words, the cow stable should be as clean as a dining room and the cows and the milker as clean as the household cook.

The Action of Heat on Sweet Milk and Cream

When sweet milk or cream is heated the following changes are likely to take place:

1. A small amount of carbon dioxide is driven off.
2. The albumen is coagulated, although but slightly at low temperatures such as 145° F., and the amount of the albumen coagulated increases as the temperature of the milk rises.
3. The casein is changed so that rennet does not act on it in a normal way; this interferes with the

usual method of making cheese from heated milk.

4. A cooked taste may be imparted to milk, due to changes in the albumen and the milk sugar, but this cooked taste will disappear if the milk is only heated to a temperature of 145° F. and then left standing in a cold place for 12 to 24 hours.

5. The bacteria are destroyed, depending on the temperature and the length of time the milk is heated. Over 90 per cent of the bacteria are destroyed by heating to a temperature of 145° F. for 20 min., and 95 per cent to 98 per cent of the bacteria are destroyed by heating to higher temperatures.

6. The viscosity of the milk and cream is changed by heating to temperatures above 145° F.

The effect of pasteurizing on the viscosity or the thickness and normal appearance of sweet cream is very noticeable if the temperature rises to 150° F. and is continued for some time.

The longer the period of heating at the pasteurizing temperature the larger the number of bacteria destroyed, but on the other hand, the viscosity or "rich" appearance of the cream is considerably reduced by continued heating.

When milk is first heated in the pasteurizing process to a temperature above 145° F., it will be noticed that it has a very thin appearance; and if such milk is bottled without careful cooling, the depth of the cream line is much reduced.

This tendency of sweet cream to have a thin appearance and the depth of the cream line on bottled milk to be reduced by heating may be overcome by rapid and continued cooling after the heating.

If milk or cream is carefully heated to a temperature not higher than 145° F. and not allowed to exceed this temperature for a heating period of 20 minutes, the consistency of the sweet cream and the thickness of the cream on bottled milk may be restored by cooling to a temperature of 40° F. and holding at this temperature for a period from 12 to 24

hours. The longer the heated milk or cream is held at a cold temperature the more nearly the consistency returns to that of raw milk and raw cream.

Certified Milk

The methods and standards required for the production and distribution of "certified" milk are given in a pamphlet published by the American Association of Medical Milk Commissioners, the National Headquarters of which is 4175 Irving Park Boulevard, Chicago, Ill.

In a general way certified milk means milk that is produced by dairymen who are under the control of a Medical Milk Commission designated by a representative medical society.

The National Association of Medical Milk Commissioners promotes the adoption of uniform standards relating to: 1. The veterinary inspection of herds. 2. The sanitary inspection of farms and equipment. 3. The medical inspection of employees handling the milk, and 4. The bacteriological and chemical examination of the milk.

A Medical Milk Commission ordinarily includes at least five members and they become responsible for: 1. The hygiene of the dairy. 2. The veterinary supervision of the herd. 3. The medical supervision of the employees, and 4. The chemical and bacteriological examination of the milk.

The Commission designates: 1. A sanitary inspector. 2. A veterinarian, 3. A physician, and, 4. An analyst.

These officials enforce the methods and standards, and make regular reports of their inspections and examinations. A written agreement may be entered into with any dairymen who are desirous of undertaking the production of certified milk, and if the reports are favorable, the dairyman is authorized to use the terms "certified milk" and "certified cream."

The following are some of the points on which the inspectors pass judgment in regard to any dairyman who wants to supply the public with this kind of milk or cream:

1. The hygiene of the dairy building must be satisfactory as to: 1. Sanitary construction. 2. Drainage. 3. Location in relation to a dusty road, cultivated fields and other sources of contamination, and 4. Condition of sur-

rounding buildings, which must be clean and free from accumulated dirt, etc.

2. The milking stable must answer to the following conditions: 1. Waste products are easily removed. 2. Floors must be cement. 3. Side walls smooth. 4. Drinking and feed troughs clean. 5. Stanchions comfortable. 6. Ventilation that will provide a minimum of 600 cubic feet of air space per cow. 7. Sufficient windows to provide 4 sq. ft. of area to each 600 cubic ft. of air space. 8. Flies excluded. 9. Children not allowed in the building during milking time.

3. The milk receiving room is a building near the milking stable but is not directly connected with the stable.

4. The dairy building shall be located at least 300 ft. from any stable or dwelling and be provided with necessary milk cooling facilities. It shall be used for no other purpose than handling dairy products and milk utensils. The light, ventilation, and drainage shall be satisfactory and no part of the building used for dwelling or lodging purposes.

The room in which the bottling of milk and cream is done shall be entered only by persons employed or by official inspectors.

The water supply shall be absolutely free from contamination and the methods of cleaning and sterilizing the bottles and utensils must be used according to prescribed regulations.

5. The herd management and the stable routine regulations cover such points as 1. The drainage conditions of the pasture. 2. The exclusion of animals such as horses, dogs and cows from coming in contact with the certified herd. 3. The kind of bedding used in the cow stable. 4. The disposal of the manure. 5. The cleaning of cows. 6. The feeding of the cows, and, 7. The amount of exercise given the cow.

6. The veterinary supervision of the herd includes, 1. A description of the method of testing the cows for tuberculosis. 2. The marking of all cows. 3. The disposition of sick cows. 4. The treatment of cows during the calving period and, 5. The use of the milk before and after this time.

The veterinary inspector must be notified of any disease among the cows at any time, and each cow shall be subjected to careful physical examination at least once each month.

7. Milking employees must comply with the following rules: 1. Wash their hands with soap and water before each

milking. 2. Milking with moistened hands is not permitted. 3. The milkers must wear clean, white suits and caps and each milker provided with not less than three freshly laundered white suits each week. 4. The milkers and other employees are not allowed to use tobacco or intoxicating liquors about the dairy or while handling the milk, and 5. No milker shall permit his hands, fingers or mouth to come in contact with milk intended for sale. He shall be careful not to touch anything but the clean top of the milking stool, the milk pail and the cow's teats. 6. Milkers are forbidden to spit on the floor or on the walls of the stable or into the water used for cooling or cleansing purposes.

Toilet facilities for the milkers and others handling milk shall be provided outside the stable or milkhouse, and all employes are required to wash and dry their hands immediately after leaving the toilet room.

8. Milk handling and transportation. The first stream of milk from each teat shall be rejected in milking the cows and this milk shall be passed through a fine sieve to aid in determining the absence or presence of garget. This milk shall also be collected in a separate vessel and not milked on the floor or into the gutters. If the milk from any cow is bloody, stringy, or in any way unnatural, that cow shall be removed from the milking herd and not returned until approved by the veterinarian. After milking, which shall be done rapidly and quietly, the milk shall be removed from the stable, strained through strainers made of double layers of finely meshed cheesecloth or absorbent cotton, and several strainers shall be provided for each milking in order that they may be frequently changed.

The temperature of the milk shall be reduced to 50° F. immediately after milking and remain at a temperature above freezing, but below 50° F. until delivered to the consumers.

The milk bottles shall be sealed on the farm where the milk is produced and the seal over the cap shall include a sterile hood completely covering the neck of the bottle and marked on the exposed surface with the approved design of the American Association of Medical Commissioners.

Certified milk may be transported and delivered in cans if these are properly sealed and marked under the medical supervision.

Certified milk shall be delivered to the consumer in the shortest possible time after production as determined by each individual milk commission. Distributors handling certified milk must keep the bottles packed in ice in warm weather and must not allow them to freeze in cold weather; and no bottles shall be collected from a house in which there is any communicable disease.

9. Methods and regulations for the medical examination of employees. A medical officer known as the Attending Dairy Physician, shall be selected by the commission, and in some cases it may be necessary to designate a separate physician for each dairy. Every new employee shall be examined by the medical examiner before assuming his duties. The physician shall visit the farm each week and examine all men employed thereon and report to the medical commission on blank forms supplied for that purpose. This report must be signed by the farm owner or manager.

In case of illness among the employees the patient shall be removed from the farm and isolated until the visiting physician has declared him to be in normal health. All employees shall be vaccinated for small pox, and when employees live upon the premises in dormitories, these shall be constructed and operated according to plans approved by the Commission.

10. Standards: Certified milk must be clean, pure, fresh, and in its natural state, not having been heated and without the addition of coloring matter or preservative. Nothing must be added to the milk and nothing taken away.

All milk samples required for examination shall be furnished by the distributor and collected at the discretion of the Milk Commission. Reports of the examination shall be sent to the producers and distributors. Samples to be examined must be in original packages.

Certified milk shall contain not over 10,000 bacteria per cubic centimeter, and if daily counts show milk to be above this for ten days, the certification may be suspended.

The taste and color, as well as the odor of the milk, shall be determined, and careful examination made of samples previously examined for bacteria.

The fat standard shall be an average of 5 per cent butterfat, with a minimum of 3.5 per cent. This average shall be based on a period of not over 90 days.

The percentage of butterfat in certified cream shall either be stated on the cap or conform to legal standards.

The methods and technique used in bacteriological and chemical analyses shall conform to standard methods of the American Public Health Association and the American Association of Official Agricultural Chemists.

Other Milk Standards: Nearly all large cities have some kind of a milk ordinance which provides regulations for producing, distributing and inspecting milk of different grades and prices. In some cities there are two grades, "raw" milk and "pasteurized" milk, each ordinance designating the standards that must be complied with for producing and delivering not only these two grades, but others which may include "inspected" milk and milk of grades "A," "B," and "C," either raw or pasteurized.

Information regarding the regulations for the production, distribution and inspection of milk in any city may usually be obtained by corresponding with the Board of Health of that city.

CHAPTER VIII

Cow Milkers' Questions

A. Some Causes of Variations in the Weight and Test of a Cow's Milk

It is a well established fact that cows are born with a capacity to give milk of a certain richness, and this is not changed during the life of a cow except for short periods when disturbing conditions may cause the milk to be a little thinner or a little richer than normal for the cow when in good health.

Observations made at different experiment stations in this and other countries have demonstrated that rich feed does not make rich milk, neither does poor feed make thin milk. If this were not true it would be possible to get both skim milk and cream from the same cow by changing the feed.

As a rule an underfed cow gives richer milk than the same cow when she is well fed, because underfeeding has a tendency to dry up the milk flow, and the milk of a cow nearly dry is richer than the milk of the same cow when fresh.

The milk of one cow will vary in amount and in richness from day to day more than the milk of a herd, and some of the causes of changes in the amount and the richness of cow's milk from day to day are discussed in the following pages.

1. The Individuality of the cow. This has a striking influence on the variation in test as well as in the amount of milk a cow gives from day to day. A cow with a quiet disposition will, with quiet handling, give milk of about the same richness during her milking period. Little disturbances do not change the test of her milk nearly so much as the same annoyances may effect the milk of a high-strung, nervous cow. The nervous system seems to have an important influence on milk secretion, and a sensitive cow may show great variation in the test of her milk from one milking to another, while a cow with a quiet disposition will chew her cud and be but little disturbed by her surroundings.

A difference in test of .5 per cent fat and even more than 1. per cent may be noticed in the milk of a cow at the two milkings in one day, but such variations often equalize each other, and milk of unusual richness at one milking is generally followed by a milking of exceptionally thin milk.

Nearly every kind of a variation has been noticed in the amount and the richness of the milk of some cows from one milking to another, and there seems to be no uniform relation between quantity and quality of milk from one milking to another, although the individuality of the animal has a great influence on the uniformity, the weight and the test of the milk produced each day.

Some cows are underfed. The amount of milk a cow is capable of producing is unfortunately an unknown quantity with many cows, simply because their owners will not give them feed enough. The grain ration and other feed are dipped out to all cows in the herd in like quantities, and the milk each one gives is supposed to be the best she can do. This may be true; but each cow has her individual capacity which should be found out.

A certain amount of feed is naturally needed to keep the animal in normal health, and in normal weight, but no one can afford to keep a dairy cow on this basis, as the profit she makes will come from the amount of feed she will convert into milk above her maintenance ration without becoming sick. It is therefore necessary to determine first of all whether a cow will respond with milk or with increase in live weight when she is given an abundance of feed. No amount of care and feed can make some cows increase their milk flow any more than it is possible to make a trotter of a draft horse by feed, or make a man handsome by changing his boarding place. Some cows give but little milk no matter how they are fed, but a cow having the so-called "dairy temperament" is just as stubborn the other way. She converts her excess of feed over a maintenance ration into milk and it is difficult to fatten her during the milking period.

2. The lactation period. The time a cow gives milk between calving and drying-up of the milk flow, is called her period of lactation. The length of this period differs with different cows, depending on the natural characteristics of

the cow, the way she is milked, and the time of the year when the milking period begins.

The general tendency with cows is to give the maximum amount of milk soon after freshening, or early in the lactation period, with the flow of milk gradually diminishing until the end of the period, when the cow is dry.

By dividing the lactation period into four parts the following figures were obtained from the daily record of one cow:
The 3rd week she gave 30 lbs. milk testing 3.3 per cent fat.
The 22nd week she gave 20 lbs. milk testing 4.6 per cent fat.
The 31st week she gave 12 lbs. milk testing 4.5 per cent fat.
The 44th week she gave 3 lbs. milk testing 8.0 per cent fat.

There is more or less variation in the rate at which milk of different cows becomes richer as the period of lactation advances, but an average figure obtained from the milk records of a large number of cows has been reported as follows:

The first month the milk tested 3.75 per cent fat.
The third month the milk tested 3.5 per cent fat.
The last month the milk tested 4.14 per cent fat.

By dividing the lactation periods of five cows into months, the following results were obtained.

Milk Pounds and Fat per cent in the Daily Milk of Several Cows in the Same Herd:

Month of Lactation Period	Cow No. 1		Cow No. 8		Cow No. 4		Cow No. 5	
	Milk lb	Fat %	Milk lb	Fat %	Milk lb	Fat %	Milk lb	Fat %
1	23	4.5	24	3.7	30	2.9	26	3.6
3	17	4.7	18	3.3	26	3.2	31	3.5
5	19	4.6	12	3.7	30	3.1	23	3.5
7	16	5.4	16	3.7	19	3.6	20	3.5
9	13	5.7	14	3.8	11	3.8	16	3.8
11	3	6.4	14	3.8			6	4.1
13			9	4.2				
14			6	4.7				

These records illustrate some of the peculiarities of different cows in the changes in quantity and quality of their milk through one lactation period. The milk of cow No. 1

decreased gradually in flow and increased in richness during an eleven month period. No. 3 gave milk for 14 months; and when she finally was dry the richness of her milk had not increased very much. Cows Nos. 4 and 5 had shorter milking periods and the decrease in flow of milk was rather sudden, with not much increase in richness at the end of the lactation period.

A cow having a natural tendency to give milk will often continue milking until near calving time, and such a one is nearly always a profitable cow, even if she does not give a large quantity at any one milking. The cow giving a large flow of milk for a few months and then standing dry for several months is less likely to be profitable than the persistent milker. A "standing dry" period of one to two months is a good rule to follow.

The period of lactation may be lengthened by milking the cow regularly and by carefully stripping her at each milking. Failing to do this will tend to dry up the cow, and this is sometimes necessary in order that she may have a period of about six weeks rest between lactation periods.

A record of one cow in which the milk she produced at each milking for 307 days was tested, showed that the highest per cent of fat found in any one milking was 12.3 per cent, while the lowest was 2.9 per cent fat. The average test of this cow's milk was 5 per cent fat.

Another cow milked for 332 days, gave milk at one milking that tested 8 per cent fat, and at another milking it tested 2.2 per cent fat, with an average test during the entire milking period of 3.7 per cent fat.

These figures show that with nearly all cows there are some milkings during the year when the per cent of fat varies considerably from the normal milk of that cow.

The test or per cent of fat in a cow's milk from day to day furnishes not only a means of calculating her value as a producer of butter, but it may serve to show the physical condition of the cow, as there is usually a good reason for a sudden change in the richness of the milk from one milking to another.

When a cow is a large milk producer and she is being fed to make a record, her owner or feeder watches the daily test of her milk very carefully. If the milk test suddenly increases

or decreases, the temperature of the cow is taken and questions asked about her treatment as to whether she has broken loose in the night or anything happened to her between milkings, that would help to explain the variation, as it has been learned that by watching the tests of a cow's milk one may judge of her physical condition in much the same way as a physician gets information about a patient's health by feeling his pulse.

3. Different portions of one milking. No one thing probably interferes more with the accuracy of the results obtained by an experienced person in testing the milk of each cow in a herd than the failure to take into consideration the difference in richness between the first and last milk obtained from a cow at one milking. When the average richness of the milk given by a cow is desired, all the milk she produces at one milking, including the "strippings" as well as the "fore" milk, should be included in the total milk of that milking.

The difference in test or in the richness of a cow's milk at the beginning and the end of one milking is illustrated by the following figures, taken from the records of the first and the last quart of milk drawn from each of three cows at one milking:

	Cow No. 1	Cow No. 2	Cow No. 3
First quart of milk (fat per cent)	1.4	1.8	1.0
Last quart of milk (fat per cent)	7.4	4.3	6.4
Milk given at this milking, lbs.	40.0	28.0	40.0

The cause of this difference in richness between the first and the last milk is sometimes said to be due to the raising of the cream on the milk in the udder. This is extremely doubtful, because milk is secreted during the milking process, and it is not all ready formed when milking begins.

One explanation of this difference in richness, is the suggestion that the fat in the milk accumulates in the fine tubes or ducts of the cow's udder from the first to the last of the milking and as the milking proceeds the hand pressure and the manipulation of the teats being greatly increased, forces out this butter fat from the fine ducts and makes the last portions or the "strippings" richer than the first milk. This is well illustrated by the following results:

A cow was milked dry; the milk obtained was divided into three portions, the per cent of fat in these three portions was:

First, 1.04; second, 3.57; third, 8.61. The average of the mixed milk of this milking was 3.6 per cent fat. A second milking of the cow after a rest of 15 minutes, gave a small quantity of milk which contained 7.8 per cent fat; a third milking after another period of 15 minutes, contained 6.0 per cent fat, and a fourth milking after 15 minutes contained 4.4 per cent fat; showing that the difference in the richness of the milk is not due to a change in the milk secretions or the creaming of milk in the udder, but that some of the fat of the milk is mechanically held in the fine ducts of the cow's udder and when these are rinsed out, the milk returns to about its normal richness or fat content as in this case, from 3.6 to 4.4 per cent, the latter figure representing the newly formed milk in the last 15 minute period after the ducts had been rinsed out by the milk secreted during the two preceding 15 minute periods; the newly formed milk having about the normal per cent of fat.

Many analyses have shown, however, that the difference between the first and the last milk is confined almost wholly to the per cent of fat, and that the other constituents, casein, milk sugar, etc., are present in about the same amounts in the milk from the beginning to the end of a milking. It has also been noticed that other things besides milking, that give the udder extra manipulation, such as the butting of a calf, moving around through the day, and the extra manipulations given by milking on the right side of the cow, have a tendency to increase the fat per cent in the milk, as the night milk is richer than the morning milk when the interval of time between the milkings is the same and the milk from the right side of the udder is richer than that from the left side because of the greater manipulations on the milking side of the cow.

4. Intervals Between Milking. The question is often asked, "Which is richer, the morning's or the night's milk?" The answer to this question is another question, "What time are the cows milked in the morning and at night?" If the two milkings are at five o'clock and there is just 12 hours between them, there will be very little difference, if any, in amount, and in richness of the milk in the two milkings.

When farmers are busy during the long days of the year, the cows are often milked at 4:00 a. m. and at 8:00 p. m. At such times there is an interval of eight hours between night and morning milkings and sixteen hours between morning and night milking. Under such conditions the morning milk is the richer, because the longer the time between milkings, the thinner the milk.

5. The number of milkings in a day. The practice of milking cows twice each day is nearly universal. Some cows, giving large quantities of milk may be profitably milked three times in twenty-four hours. One observer found that when the day was divided into three periods; morning, noon and night and the number of hours between each milking of the three periods was 9 hours, 8½ hours and 6½ hours, the following average figures per cow were obtained during a six months' record of a herd, where three daily milkings were made.

	Morning Milking	Noon Milking	Night Milking
Milk, pounds	8.5	6.7	5.1
Fat per cent	2.7	3.0	3.7
Hours preceding milking	9	8½	6½

The least and the richest milk was obtained after the shortest period of time between milkings. This is in accordance with the usual observations, but it has also been noticed that the evening milk may be richer than the morning milk, even when the time which elapses between the two milkings is longer at the evening than at the morning milking.

It is claimed that the exercise a cow gets during the day tends to make the udder secrete richer milk than during the quiet night period. There is no doubt that the act of milking excites the activity of the milk glands and consequently the greater number of milkings in the day the greater the amount of milk obtained. But whether or not the increased amount obtained will cover the expense of the time and labor required for more than two milkings per day is a question that each one must decide for himself.

6. Milking each quarter of a cow's udder separately. It has been shown by a number of trials that when the milk from each quarter of a cow's udder is drawn into a separate pail, then weighed and tested, that there is a difference in

the amount and the richness of the milk obtained from the different quarters. The average of four trials made with one cow, in which each quarter of her udder was milked into a separate pail gave the following results:

	Milk lbs.	Fat %
Right fore teat	2.17	3.76
Right hind teat	2.15	3.93
Left hind teat	2.95	4.26
Left fore teat	2.05	3.69
	9.32	3.92

It was found, however, during these trials that the difference was not always the same, but that the amount and richness of the milk obtained from each quarter of the udder was influenced by the order in which the different quarters were milked. The quarter milked first usually gives more milk than the quarter milked second on one side of the cow's udder, suggesting that there is some passage of the milk between the two quarters on one side. The two fore quarters or the two hind quarters of the udder did not give a larger amount of milk from the quarter milked first, suggesting that there is no passage of the milk from one quarter to the other on the opposite sides of the cow.

7. Milking fast and slow. It is often claimed that a strong, fast milker will get more milk than a boy or than a milker who prolongs the milking time by indifferent attention to his work. The effect of fast and slow milking was tried on nine cows which were each milked rapidly, that is—within three or four minutes, for a number of milkings and then the same cows were milked slowly, doubling the time of the first milkings, some cows being milked fast and some slowly each day, so as to eliminate other disturbing conditions. The results showed in every case that the fast milking gave a richer milk than the slow milking, the gain in butterfat from the fast milking being 11.7 per cent for the herd.

8. Change of milkers. Nearly everyone who has owned and milked cows knows that the milker has a great influence, not only on the amount of milk obtained from a cow, but on the persistency with which the cow continues to give milk. Some milkers will dry up the cows, while others by their way

of milking will develop the milk producing qualities of a cow so that she is constantly gaining in milk production from year to year. Many trials have been reported of the difference in the amount of milk obtained from the same cow or cows by different milkers. From one cow in a herd a good milker got 18 pounds of milk testing 4.2 per cent fat, while a poor milker got 12.5 pounds of milk testing 2.7 per cent fat. At the Wisconsin Agricultural College one milker got 244.5 pounds more milk from five cows in a two weeks' period than a poor milker got from the same cows in two weeks. A trial is reported by Babcock in which four cows were milked for periods of one week by each one of three men, all of whom were considered good milkers. The results showed that one of these three men always got more milk and more butterfat than the other two men.

The greatest difference in the yield of milk always occurs at the first milking after the change of milkers, but in the 16 changes from milker A to B there was obtained 1.7 pounds more butterfat by B than by A in milking the same cows. The following figures give a summary of the results calculated per cow per day:

	Cow No. 1		Cow No. 2		Cow No. 3		Cow No. 4	
	Milk lbs	Fat %	Milk lbs	Fat %	Milk lbs	Fat %	Milk lbs	Fat %
Milker A.....	20.2	4.5	15.3	4.45	21.0	3.94	17.8	3.9
Milker B.....	22.0	4.85	16.2	4.75	23.6	4.84	18.	4.1
Milker C.....	20.0	4.85			18.8	4.06		

These figures show that B got more and richer milk from the same cows than the other milkers got, and with cow No. 3 he got over one quart more milk and the milk was richer than that obtained by either of the other milkers. Another observer reports that from six cows there was obtained 22.3 pounds milk testing 10.6 per cent fat by stripping them immediately after they had been milked by careless milkers. This amounted to 2.4 pounds of butterfat, or 2¾ pounds of butter, which at 50 cents per pound is $1.37, as the loss at one milking from six cows by careless milkers.

9. Change of quarters. The effect of transportation and change of stabling with cows exhibited at County Fairs has frequently been noticed and the so-called "milk tests" at these fairs sometimes made from one or two milkings only, are likely to give an erroneous impression of the milk producing qualities of the cows under normal farm conditions.

The following instance illustrates what may be expected when cows are transferred from one stable to another. Two cows were taken from the home stable to a neighboring barn, one mile away, and at the first milking of these cows in their new quarters one cow gave 2 lbs. less milk and this milk tested 1 per cent less fat than at the last milking before leaving her home quarters. However, at the second milking in the new quarters the loss in the first milking was recovered and this cow continued to give her normal flow of milk. The other cow showed the same tendency, giving nearly 1 lb. less milk, which tested 1.5 per cent less fat at the first milking in her new quarters, than she produced at the last milking in her old quarters, but she recovered her normal milk flow later.

10. Weather exposure. Nearly every creamery and cheese factory operator has noticed the effect of continued hot weather in summer and of a cold raw wind or storm in any season of the year, on the milk supply received at his factory. The loss from such exposure of the cows can be more than saved by providing a shelter in the pasture in the summer and comfortable quarters in the winter. One of the demonstrations of this fact is the observation reported by Prof. Plumb some years ago. He made a comparison of the amount of milk obtained from three cows kept in a comfortable stable during February and March with the amount of milk given by three cows left outside the stable and exposed to the weather at that season of the year, both lots of three cows were given the same kind of feed and as much roughage as they would eat.

The results showed that the cows in the comfortable stable ate less feed, gained more live-weight and gave more milk than the exposed cows. A gain of $4.30 worth of milk per cow of those kept in the stable as compared with the cows left outside the stable exposed to the bad weather for a period of six weeks was reported in this trial.

11. Milking a cow dry. A great many persons when milking cows are in too much of a hurry to get through milking and leave some of the richest milk in the cow's udder. This loss may amount to one-half a pound of milk from each cow at a milking, as was found to be the case of a farmer who followed his hired man and milked all the cows after him. By this second milking the farmer got over one pound of milk from some cows and less than one-half a pound from others; from ten cows he got five pounds of "strippings" at one milking. This last milk, or "strippings," is always richer than the first milk and in this case the five pounds of milk tested 5 per cent fat, which amounts to one-quarter of a pound of butterfat at one milking and one-half a pound of butterfat for the two milkings in one day. At present prices, this butterfat is worth at least twenty-five cents which may not seem to be a very large sum, but in 300 days, an average milking period of a cow, it amounts to $75.00 or nearly enough to buy a new cow.

It has been estimated from careful observations that the yield of milk a cow gives may be permanently increased nearly 12 per cent in a year by systematic udder manipulation and by milking the cows dry at each milking, and further, that since there is such a difference in the way cows are milked by different persons it is evident that some milkers are worth at least $14.00 a month more than others because of the larger quantity of milk a good milker will obtain from a number of cows as compared with a careless milker.

An experiment made at the Wisconsin Experiment Station, showed the difference in the amount of milk obtained by four men from a herd of 15 cows.

Milker No. 1 left .17 lbs. of butterfat per cow in the strippings; Milker No. 2 left .05 lbs.; Milker No. 3 left .19 lbs.; Milker No. 4 left .2 lbs. butterfat per cow per day in the strippings.

These figures show a difference between the extremes of .15 lbs. of butterfat per day and if these 15 cows were milked 300 days in a year the total loss is 675 lbs. of butterfat, which, at 50 cents a pound, amounts to $337.50, showing that the owner of these cows could easily afford to pay the best milker nearly $1.00 per day more wages than the poor milker.

12. Age of the cow. The usefulness of any cow as a milk producer will naturally depend on her individuality and her treatment during the years of her life, but under the best conditions there is a limit to the number of years she will give milk at a profit. The rate at which the milk production increases and decreases during the average life of a cow has been studied by a number of investigators.

An inspection of the records of 150 cows gave the following results:

Lactation period	1st	2nd	3rd	4th	5th	6th	Beyond 6th
Milk, pounds	5,490	6,600	7,040	7,209	7,535	7,434	6,790
Fat per cent	3.65	3.68	3.64	3.65	3.61	3.62	3.58

Another study of records of 2,454 cows showed an increase in the annual milk production up to the seventh lactation period, and after this a decline with a slight change in the per cent of fat in the milk from 3.37 in the first to 3.19 in the sixth lactation period.

The evidence indicates that cows as a rule begin to decline in milk production after the sixth to the eighth lactation period.

13. The effect of Drought. It is a well known fact that the lack of feed for cows during a long and continued drought will diminish the flow of milk and usually when a cow "dries up" the per cent of fat in her milk increases. It has been noticed, however, that during a severe summer drought, the yield of cheese per 100 pounds of milk is not what would naturally be expected from normal milk of a given per cent fat. This led to an investigation which showed that the per cent of solids not fat in the milk, which usually is comparatively uniform was decidedly low in the milk of cows receiving scant feed during a dry season.

At a factory where themilk of 50 patrons was received, the solids not fat in the milk was about 9.0 per cent in April, May and June, but in July and August it dropped to 8.4 per cent. It was further shown that in those herds fed grain during the drought, the per cent of solids not fat, in the milk was about normal, while with no grain feeding it was low.

The average of five herds which were fed grain during drought was 4.28 per cent fat; 8.82 per cent solids not fat,

and 11.03 pounds of cheese per 100 pounds of milk was made. The average of five herds receiving no grain during drought was 4.02 per cent fat; 8.19 per cent solids not fat, and 9.86 pounds of cheese for 100 pounds of milk. A similar condition of the milk has been noticed at other cheese factories, showing that long continued drought and insufficient feed at such times has a tendency not only to reduce the milk flow but to reduce the per cent of solids not fat in the milk. This makes a low yield of cheese, although the per cent of fat in the milk would indicate the contrary.

14. Warm or cold drinking water. An exhaustive study of the effect of warming the drinking water in winter on the milk production of cows was made by Prof. F. H. King. His observations were made during two winters from about Jan. 21st to March 31st, covering periods of 64 and 80 days respectively. Six cows kept in a good stable were divided into two lots. To one lot of three cows was given water at 70 degrees F. and to the other lot of three cows water at 32 degrees F. Each lot was given water at one of these temperatures for a period of about 16 days and then changed to water of the other temperatures.

The observations showed that the cows receiving the warm water drank about 10 pounds more water, ate more food and gave about 1.0 pounds more milk during one year, and ¼ pound more milk the second year per day per cow than those given cold water. The cows on cold water required 1.54 and 1.41 pounds food per pound of milk, and those on warmer water 1.44 and 1.39 pounds.

A calculation of the financial difference in the returns from the two lots based on the same prices of feed and milk, and assuming the cost of warming the water for 40 cows during 120 days to be $15.00, showed a profit of $26.40 the first year and a loss of $5.98 the second year.

Every cow showed a preference, except one, for the warm water. Other investigations report little or no financial gain from warming the water for milk cows, but it is a fact that a sensitive cow especially when fresh in milk, may be injured by drinking cold water, while other cows not accustomed to a comfortable stable and producing little milk, may not be disturbed in any way by drinking cold water.

B. Relation Between Weight of Feed and Pounds of Milk a Cow Gives

The effect of the feed on milk secretion is a matter of importance independent of the compounding of rations. Economical milk production depends somewhat on healthy and active milk glands; and, since such glands, like muscles, are nourished by protein feeding stuffs, an ample supply of this constituent should be available in the feed of milch cows. The fat in feeding stuffs is also important, as it doubtless aids in supplying the fat of milk, although the food fat is changed by the digestion process and does not appear as such in the milk. A sufficient amount of food fat has a favorable action on milk secretion, but an excess not only makes a feed too expensive, but it may disturb digestion and thus reduce the flow of milk. An insufficient amount of fat as well as a scanty supply of other feed fails to keep the animal up to her highest producing capacity, and this deficiency may reduce the flow of milk. It is necessary, therefore, to supply cows with an ample quantity of feed of the right kind in order to keep the milk glands in a heathy and active condition.

The effect of the amount of milk and of butterfat produced by a cow on the feed she consumes can be illustrated by the following figures:

If it is assumed that a dry cow weighing 800 lbs. needs about 10 lbs. of dry matter in her feed per day, then this cow, when she is producing one-half a pound of butterfat per day in her milk, should receive about 16 pounds of dry matter in her feed; and when she is producing one pound of butterfat, she needs 18 pounds dry matter in the feed, and for two pounds of butterfat, 28 pounds of dry matter in the feed per day. Heavier cows need more feed.

The following feeding rule, which uses no calculation of the digestible protein, carboyhdrates, etc., etc., needed per cow per day, has been suggested.

Each cow should receive as much roughage as she will eat up clean, and a portion of this should be preferably of a succulent nature, such as grass, silage, crops or roots.

Of concentrates, feed as many pounds of grain per day as a cow produces pounds of butterfat per week, or one-fourth to one-third as much grain as she gives pounds of milk daily, this amount depending upon the per cent of butterfat in the

milk. In the case of cows producing milk with a low per cent of fat, one-fourth as much grain should be given the cow as she gives pounds of milk daily.

If a cow gives 30 lbs. of milk per day and its test is 4.0 per cent fat, then this milk contains $30 \times .04 = 1.2$ lbs. butterfat per day; and multiplying 1.2 lbs. by seven days gives $1.2 \times 7 = 8.4$ lbs. as the grain ration of this cow per day. Care should be taken to avoid an increase in body weight above the normal of each cow, since milk secretion, as a rule, is likely to suffer when cows commence to utilize their feed for increasing their live weights.

Digestibility and palatability of cow feeds. It has been stated that a chemical analysis of ground leather will show a percentage of protein and carbohydrates similar to those of concentrated cattle feed, but the ground leather is worthless for feeding stock of any kind. This striking example also illustrates another important point in feeding dairy cows, which is, that all the feed they receive must be fit to eat and wholesome. Musty, mouldy hay or grain and decayed silage will not give good results when fed to cows, even though the figures in a table may show them to contain important percentages of digestible protein, carbohydrates, fats, etc.

Some of the important questions to be answered in feeding dairy cows profitably are:

1. Does the cow respond with milk when given a liberal ration?
2. Are both the coarse feed and the grain mixture sound and palatable?
3. Are the cows receiving a generous supply of coarse feed of some sort?
4. Is the amount of grain mixture in the right proportion for the pounds of milk the cow produces daily?

Effect of heavy grain feed on milk production. Many trials have been made to show the relation between the amount and the richness of a cow's milk and the amount and richness of her feed. There is an impression among some cow owners that rich feed makes rich milk, and vice versa. The experiments made on this point invariably show, however, that while an increase in the grain ration may cause a gain

in the milk flow and more butter is made, there is practically no change in the per cent of fat, or in the richness of the milk. If a cow is giving 20 pounds of milk per day, and it tests 4 per cent fat, this amounts to .8 pounds butter fat or about one pound of butter per day. If her grain ration is increased she may give 25 pounds of milk per day, but this milk will test approximately 4 per cent of fat the same as it did before. This increase will make more butter than formerly, even though the test of the milk has not changed, since 25 pounds of milk testing 4 per cent fat gives one pound of butterfat. This is about 1.2 pounds of butter, or a gain of 20 per cent in the amount of butter made by the cow in consequence of the increase in feed, even though there was no change in the test of the milk.

The following figures were obtained in an experiment in which an attempt was made to increase the grain ration of three cows to as large a quantity as seemed safe without making the cows sick and by weighing and testing the milk daily, noting the effect on the milk of each cow.

The grain and hay or silage fed is calculated into pounds of dry matter which is given in the table instead of the pounds of feed, and the increase in dry matter pounds, represents increases in grain as the cows were fed about the same amount of roughage during the entire time covered.

Daily Feed and Milk Record of Three Cows

Feeding Period days	Dry Matter in Feed lbs.	Cow No. 1		Cow No. 3		Cow No. 5	
		Milk lb	Fat %	Milk lb	Fat %	Milk lb	Fat %
25	18	16.7	4.6	11.5	3.8	25	3.6
12	24	18.4	5.2	14.8	3.7	29	3.9
27	25	19.9	4.9	16.3	3.6	31	3.7
15	28	19.5	4.5	16.6	3.5	31	3.5
51	32	17.6	4.8	14.9	3.8	28	3.5
6	26	18.6	5.0	15.2	3.7	26	3.4
16	25	13.6	5.9	12.5	4.2	19	4.0
31	Pasture	16.0	5.2	14.5	3.7	23	3.4

The figures show than an increase in the ration from 18 pounds to 32 pounds per cow per day did not change the average test of the milk of these cows, even though the heavy grain feeding was continued for nearly four months. There was an increase, however, in the flow of milk amounting to three pounds of milk per day for cow No. 1 and five pounds and six pounds per day for cows Nos. 3 and 5 respectively.

It will be noticed that the milk flow of each cow increased on the heavy grain ration for about 60 days, that there was then a slight falling off for about 60 days, and a decided decrease in milk produced by all the cows during the last 16 days, when the ration was reduced to 25 pounds per day. But it will also be noticed that as soon as the cows went to pasture, the milk flow gained to nearly the same amount it was four months earlier in the cow's milking period.

The drop in the test of the milk when the cows went to pasture was simply bringing it back to the same richness the milk had before the cows began to dry up on account of a reduction in the grain ration.

The conclusions of all careful experiments on this point have been the same; and, as before stated, the richness of a cow's milk is a natural characteristic like the color of her hair. Changes in feed do not permanently affect the richness of her milk so long as the cow is in normal condition.

C. Sampling the Milk of one Cow for Testing

The following directions apply to the taking of a sample of milk of one cow for the purpose of testing its richness. As a rule the most satisfactory information about the test of a cow's milk is obtained by mixing two samples taken from two consecutive milkings—that is, mixing a sample of the morning's milk with a sample of the following or the preceding night's milk. This is a two-milking sample, a test of which gives fairly accurate evidence of the richness of the milk a cow gives.

A one-milking sample may be taken and tested, but the results are likely to be higher or lower than a test of a two-milking sample.

When a sample of milk must be taken from one milking, the cow should be milked dry and all the milk collected in one pail or can. This milk is then poured back and forth from

one pail to another at least three times and after this mixing, a portion of the milk is dipped out for testing.

This testing sample should be poured into a bottle which is filled to the cork if the sample is to be shipped or transported any distance. This will prevent the milk from churning during transportation, as the formation of small butter granules by churning prevent accurate milk testing. If a fat test only is wanted a four ounce bottle of milk is sufficient, but if a lactometer test is desired about one pint of milk is needed.

The accuracy with which a one-milking sample may show the average test of a cow's milk will depend somewhat on the number of hours between the two milkings of each day. If the cow is milked at six in the morning and six in the evening, the test of one milking will give a better indication of the average test of a cow's milk than would be the case if the cow is milked at five in the morning and seven in the evening. In the latter case the morning's milk will be richer than the night's milk, as there are only ten hours between the night and morning milking, while there are fourteen hours between the morning and the night milking. The longer the time between milkings the more milk a cow gives but the milk is thinner than that produced after a shorter time between milkings.

A Test of Two Consecutive milkings. A test of two milkings, one following the other will usually show the average composition of any cow's milk. The two samples should be taken in the same way as described for sampling one milking, but at the first milking the sample bottle is filled one-half full of milk and at the next milking the sample taken is poured into the previously half filled bottle.

Any sample of milk taken for testing should have a small amount of some preservative added to it, to keep the milk from souring until it can be tested. A little powdered chromate of potash or a small quantity of borax will preserve milk for testing.

A fairly satisfactory record of a cow's milk production and a test of her milk may be obtained by weighing the milk she gives at each of the two consecutive milkings and testing a mixed sample of these two milkings. If such weights and a test thereof are made one day in each month and the figures

obtained multiplied by the number of days in the month, the results so obtained will give a very close estimate of the amount and richness of the milk the cow gave during the entire month. This may be illustrated by the following example:

Weight of the morning's milk	28 lbs.
Weight of the night's milk	30 lbs.
Total weight	58 lbs.

If there are thirty days in the month then the total milk given by this cow was $58 \times 30 = 1{,}740$ lbs.

If the milk of this cow is tested one day in the month as described above and this test is found to be 3.5 per cent fat, then the pounds of butterfat in the milk for this one day would be $58 \times 3.5 = 2.03$ lbs. and for one month $2.03 \times 30 = 60.9$ lbs. of butterfat.

The record, therefore, of this cow for one month was 1,740 lbs. milk, containing 60.9 lbs butterfat.

It has been found that figures obtained by this method of weighing and testing one day in each month came within 98 per cent of the records obtained by weighing and testing the milk of a cow on each one of the thrity days and adding the figures so obtained.

A Few Points on Cow Stable Ventilation

It has been estimated by Professor King, in his book on ventilation, that the air drawn into and forced out of the lungs of a cow each hour amounts to about 117 cubic feet. This air in 24 hours will fill a space about 14 x 14 x 14 ft. in dimension, or, stated in another way, if air is supplied to cows in the same way that water is given to them, each cow needs sixty pails of air per minute. It is further estimated that the air of the cow stables and dwellings should at no time contain more than 3.3 per cent of air once breathed, and in order that the air of a cow stable shall at no time contain more than 3.3 per cent of air once breathed, it must enter and leave at the rate of 3,542 cubic feet per hour per cow.

Poor ventilation is sometimes indicated by the accumulation of moisture in drops on the walls and ceiling of the cow

stable. If 10.4 lbs. invisible vapor are daily thrown off by an animal weighing 1,000 lbs., the air in a twenty-cow stable, 20 x 40 ft. and 9 ft. high must be changed every 50 minutes when the temperature is 70° F., if the moisture exhaled in the breath of the cows is all carried off.

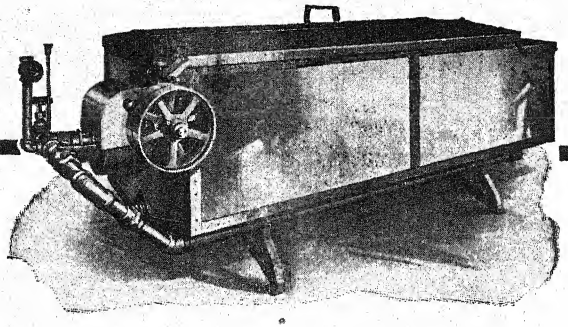
Some of the essential points in good ventilation are the following:

1. The cow stable or a room must be tight or so built that it can be made tight by closing windows and doors.
2. The exit flue for the ventilating system must be air tight like a smoke chimney for a stove and with as few bends in the flue as possible, and these flues must be insulated.
3. The openings for air entering the stable should be placed on all sides of the building about every 10 ft. apart, and the outside opening in the wall at least 4 ft. below the opening on the inside of the wall. The walls of these openings should be insulated and control doors provided for closing them.
4. The outside air should enter the room near the ceiling and the exit flue for the air should open about one foot from the floor.
5. The capacity of the entire number of inlet flues and the one or two outlet flues should be about equal, although the outlet is usually only one or two large flues, while there are many small inlet flues, some of which may be closed during cold weather. The walls of all flues should be insulated.
6. The height of the outlet flue will be governed by the difference in temperature of the outside and the inside air.

Ventilating intakes and outlets for horse and cow stables should provide not less than 30 sq. inches per head, when the outtake has a height of 30 ft. If the outtake is shorter, the area should be greater; if higher, it should be less. A 20 ft. outtake would require about 36 sq. inches per head instead of 30.

Ventilation means movement of air, and in order to get some circulation of air in a cow stable all the flues provided for this circulation must be insulated and a sufficient number of animals present in the stable to warm up the air to a higher temperature than the air outside the building.

A 1,000 lb. cow will warm 600 cubic feet of air to a sufficiently high temperature to get a movement of air in temperate climates.



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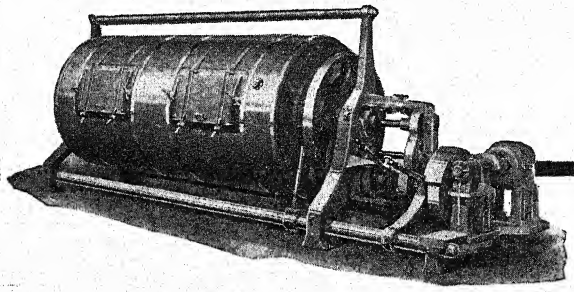

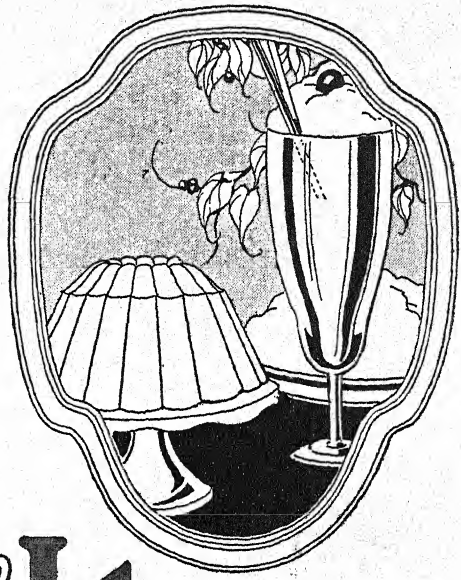

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